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BIOMECHANICS AND ANTHROPOMETRY FOR COCKPIT AND EQUIPMENT DESIGN--ETC(U)

MAR 76 S M EVANS, M J HIMES, P E KIKTA F33615-75-C-5092

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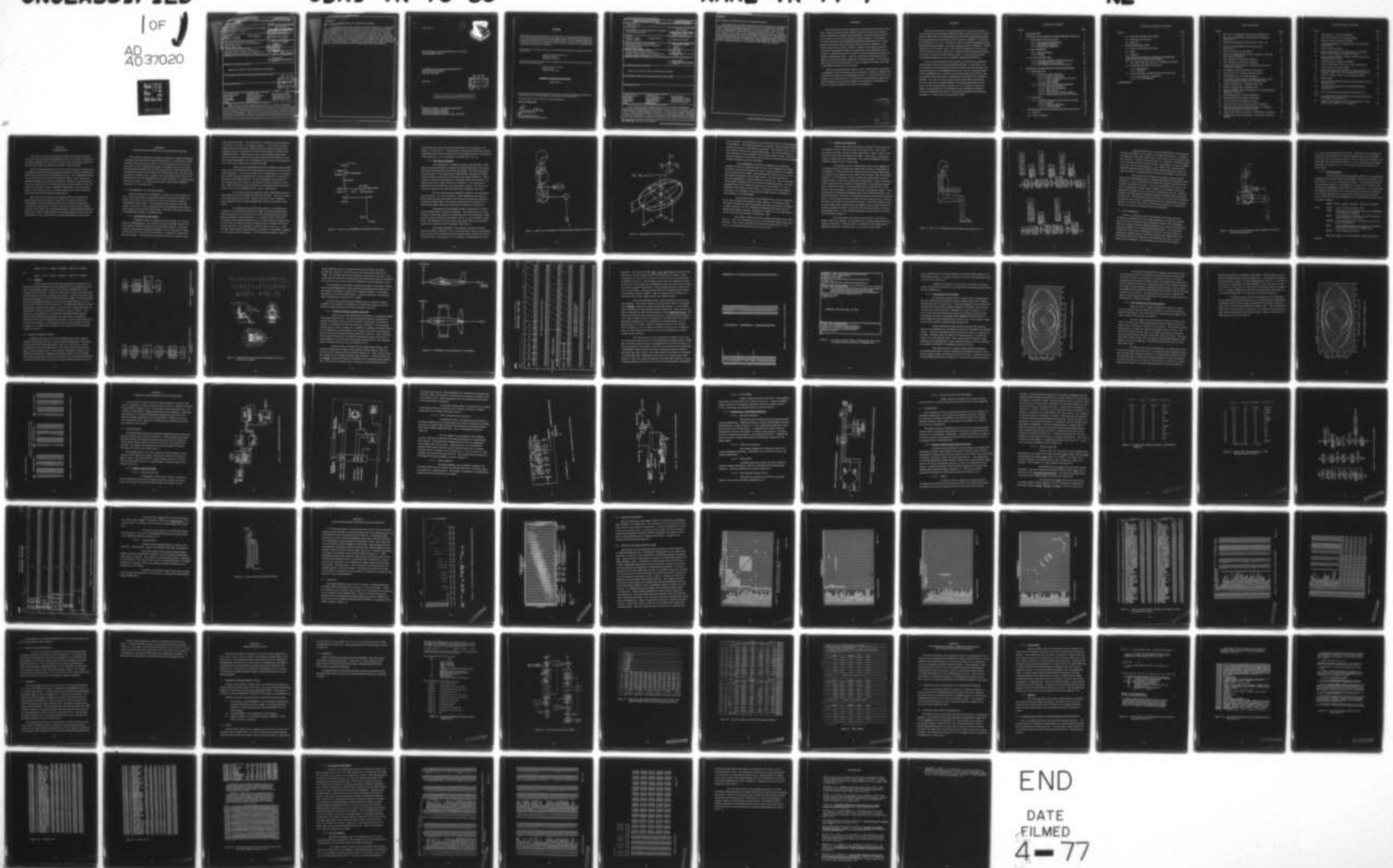

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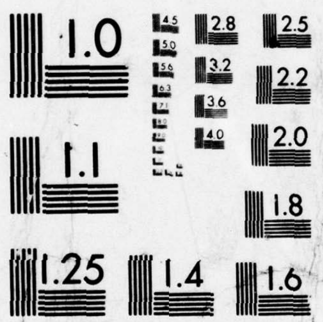

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes enhancements made to the AMRL COMBIMAN (COMputerized BIomechanical MAN-model) program in the areas of man-model link-system and enfleshment characteristics, and in the area of additional functions or options made available to the user of the interactive graphics computer program of COMBIMAN. These new functions include obtaining hard-copy plots of the man-model and workstation as displayed on the Cathode Ray Tube (CRT)

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The report also documents technical procedures followed in readying the AMRL HERCULES (Human Engineering Research to Cull Efficient Strength) Lab for measuring strength capabilities of seated operators, and the procedures established for running the subjects and gathering the data. The last area covered in this report is the development of programs and the manipulation of anthropometric data used in the analysis of human size variability data. This includes preliminary documentation for the Multiple Bivariate Plotting program, and the procedure established in standardizing the AMRL Data Bank Library Computer Programs, and the AMRL Data Bank Tape Library.

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BIOENGINEERING DIVISION
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AEROSPACE MEDICAL RESEARCH LABORATORY
AEROSPACE MEDICAL DIVISION
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

NOTICES

TECHNICAL REVIEW AND APPROVAL

AMRL-TR-77-7

This report has been reviewed by the Information Office (OI) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

Charles Bates

CHARLES BATES, JR.
Chief
Human Engineering Division
Aerospace Medical Research Laboratory

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SUMMARY

This report describes the engineering services performed by the University of Dayton Research Institute (UDRI) to provide the Aerospace Medical Research Laboratory (AMRL) with biomechanic and anthropometric data in a form readily and clearly interpretable by design engineers. The ultimate use of the data will be in developing specifications and standards for cockpit geometries of advanced aircraft and personal-protective equipment. The primary effort was to modify, maintain, validate, and document computer programs for guiding the design and evaluation of cockpit geometries and to present, in standard format, the computer programs designed for analyses of military anthropometric data. These are required for the design of workstations, personal-protective equipment, and human analogs. The secondary effort was to provide engineering and research support to studies describing strength characteristics of AF personnel.

The work described in this report is a direct outgrowth and represents a continuation of the development and documentation of AMRL's COMputerized BIomechanical MAN-model (COMBIMAN) program. It also describes the continuation of the extensive work in developing and standardizing computer programs designed for the efficient analysis of presentation of anthropometric data for guiding the design of AF systems and equipment.

PREFACE

This report documents research performed by personnel of the University of Dayton Research Institute (UDRI) for USAF Contract F33615-75-C-5092, entitled "Biomechanics and Anthropometry for Cockpit and Equipment Design". The government work unit number for this contract is 71840824. The contract was monitored by Dr. Joe W. McDaniel, of the Crew Station Integration Branch, Human Engineering Division, Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio. The principal investigator on the contract was Ms. Susan M. Evans, while Paul E. Kikta provided programming support, and Martin J. Himes provided technical support. David Nearing provided programming support for program RANDM, documented in Section 3.

The research documented in this report was performed in conjunction with personnel of the Crew Station Integration Branch. In particular, Drs. Joe McDaniel and Kenneth Kennedy provided valuable data and equations used in the generation of the COMBIMAN man-model. The link system presently used in COMBIMAN is the result of research performed by personnel in the Crew Station Integration Branch (AMRL/HED), in particular Dr. Kenneth W. Kennedy. Mr. Charles Clauser directed much of the effort involving the bivariate program, the standardization of the AMRL Anthropometric Data Base, and the biostereometric program. Dr. H. E. Krause, formerly of UDRI, also participated in the development of the enfleshment ellipsoids about the COMBIMAN man-model. The authors gratefully acknowledge his assistance, as well as that of the staff of the UDRI.

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SECTION 1
INTRODUCTION

This report covers the enhancements made to the Aerospace Medical Research Laboratory (AMRL) COMBIMAN program, the efforts to standardize the AMRL Anthropometric Data Bank, and the research support provided for studies describing the strength characteristics of AF personnel.

The work documented in this report is a direct outgrowth and represents a continuation of the development and documentation of AMRL's COMputerized BIomechanical MAN-model (COMBIMAN) program. The COMBIMAN program has been developed to provide the workstation engineer with an interactive graphics program to be used in the design and evaluation of aircraft cockpits. This report describes the procedures developed for the generation of the link system and enfleshment of the COMBIMAN man-model. It also documents features which enable the user to obtain visibility plots and hard copy plots of the man-model and workstation configurations.

This report also documents the continuing effort in developing and standardizing computer programs designed for the efficient analyses of anthropometric data for guiding the design of AF systems and equipment. In particular it describes the computer program developed to plot multiple survey bivariate tables, the research performed on AMRL-supplied biostereometric data, and the standardization effort dealing with the programs and the anthropometric survey data tapes of the AMRL Anthropometric Data Bank.

SECTION 2

FURTHER DEVELOPMENT OF THE COMBIMAN PROGRAM

This section documents the continued development of AMRL COMBIMAN (COMputerized BIomechanical MAN-model) program, as performed by UDRI personnel during this contract period. The three primary areas covered in this section are the enfleshment procedures established for the man-model, the plot program developed to generate hard copy plots of the man-model and workstation as displayed on the IBM 2250-3 Cathode Ray Tube, and the on-line generation of visibility plots. Another area of development which will not be documented here is the COMBIMAN User's Guide (Reference 1), written during this contract period. It reflects the operational status of the COMBIMAN programs as of 1 November 1976.

2.1 ENFLESHMENT OF THE MAN-MODEL

The man-model used in COMBIMAN is based on a 33-link skeletal system. Each of these links connects major points of rotation of the body segments. The model is constructed by the interactive graphics program of COMBIMAN in three stages. The first stage is the generation of the link system of the model. The second stage involves the definition of the enfleshment ellipsoids about the link system joints. The third stage is the connection of the elliptical projections with tangent lines.

2.1.1 Generating the Link System

Although 33 links are defined for the man-model, two of these links are positioning links, and are used to provide a common reference between the seat reference point of the model and the workspace. The links system is constructed by adding links together to form a link chain, starting with the link at the seat reference point (SRP). As each link is positioned, the link end point, or joint location, is defined in terms of a position vector,

with respect to the SRP. The major points of rotation of the body segments are shown in a side view of the model in Figure 1. Work of the Aerospace Medical Research Laboratory (AMRL) with two dimensional drawing board manikins formed the foundation for the three dimensional link system of the COMBIMAN model. AMRL data have been used in defining relationships between measurable anthropometric surface dimensions and difficult to measure internal link lengths, and in defining the range of values for transformation or Euler-type angles used to position the links.

When using the COMBIMAN interactive graphics program CBM04, the user has the ability to vary the proportions of the model to suite the needs of the application. The user may supply values as dimensions or percentiles for a variable number of anthropometric surface dimensions, or may insert the internal link lengths directly. To alter the position of the model, the user changes any of the values for the Euler-type angles available for each link. More information on the procedures for altering the dimensions of the model is given in the COMBIMAN User's Guide - (Reference1).

At the present time the equations used to establish the internal link lengths have not been validated against real life data. This is to be done in the upcoming contract period. Because they have not been validated, actual equations based on AMRL supplied data will not be presented in this report.

In assembling the individual links called L_i to establish joint locations in three dimensional space, the length and the three-dimensional Euler-type angles of a particular link are used, along with the three dimensional coordinate of the previous link, L_{i-1}, and the product of the transformation matrices which positioned L_{i-1}. The three Euler-type angles used for each link correspond to the three rotations of the coordinate axis of the system about link L_i to establish its location relative to link L_{i-1}. If all the Euler angles between adjacent links are specified, the geometric configuration of the man-model is specified. A more detailed description of the use

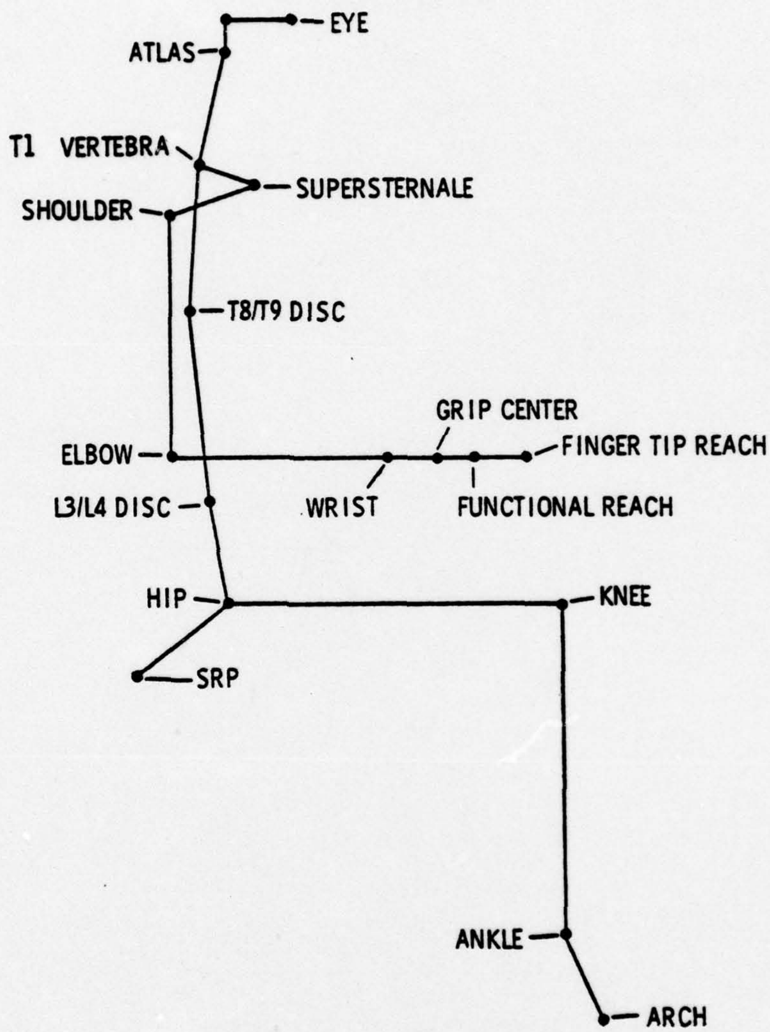


Figure 1. Side View of COMBIMAN Link System (Reference 2).

of transformation matrices and the establishment of joint locations, see Chapter 2 in Reference 3. This technique of positioning links places realistic limitations on the range of mobility of each joint and permits the repositioning of the distal link, L_i, by movement of a proximal link, say L_{i-1}.

2.1.2 Enfleshment Ellipsoids

The enfleshment, or addition of volume about the links, of the stick man-model to produce a realistic and anthropometrically correct man-model starts with the joints of the stick man-model. The joint at the distal end of each link is surrounded with an ellipsoid (three dimensional ellipse) for this purpose, as shown for a side view of the model in Figure 2. Figure 3 shows a system of coordinates for a joint at the distal end of the link L_{I_i}. This is known as the "link's system of coordinates." It is permanently attached to the end of the link, and moves with it in space. It is used to define the orientation of the next distal link which is attached to the joint.

The size and shape of an ellipsoid is defined by the dimensions of the semiaxes a, b, and c in Figure 3. These dimensions are based on body surface and mass dimensions, and derived from equations supplied by personnel of AMRL/HED. The semiaxes dimensions for each joint correspond to the height, width and breadth surface dimensions at that joint.

The position of the ellipsoid in space is determined in relation to the individual link's system of coordinates. The dimensions α, β, and γ in Figure 3 specify the distances by which the center of the ellipsoid is offset from the origin of system of coordinates in the x, y, and z directions respectively. The ellipsoid is centered at the origin of the system of coordinates, and therefore about the center of rotation, if $\alpha = \beta = \gamma = 0$.

The angular alignment of the ellipsoid is another necessary quantity to define its position. The y axes of the links' system of coordinates of the present stick-man model have been aligned with the major axis of rotation of the joint. The semiaxis b of the ellipsoid is aligned with this major

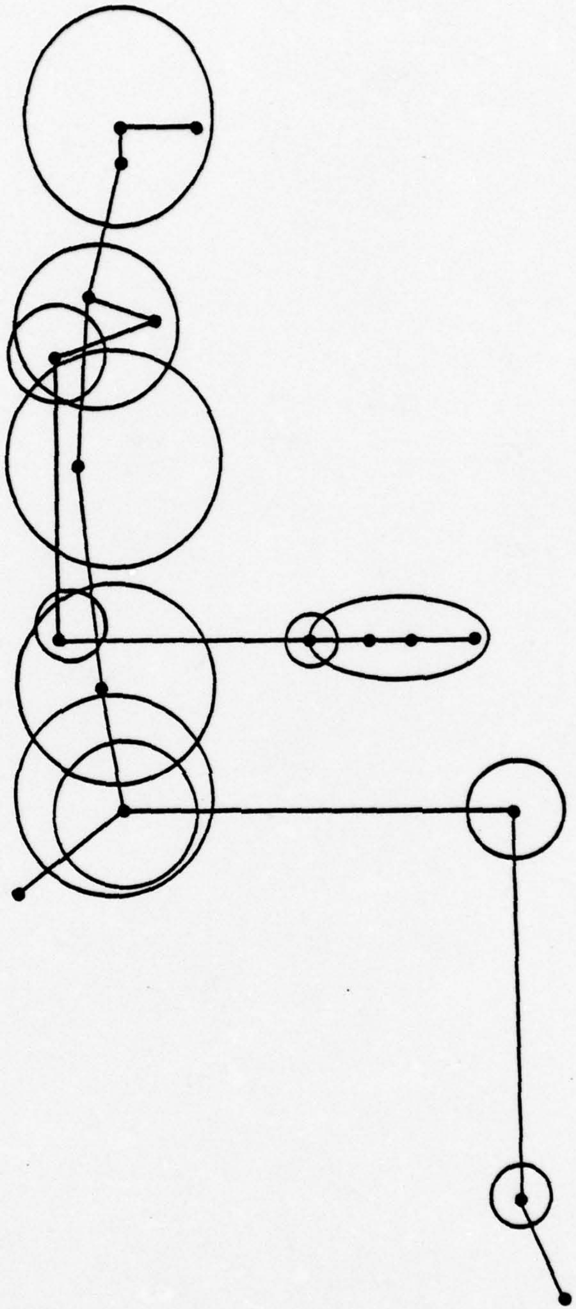


Figure 2. Side View of COMBIMAN With Enfleshment Ellipses (Reference 2).

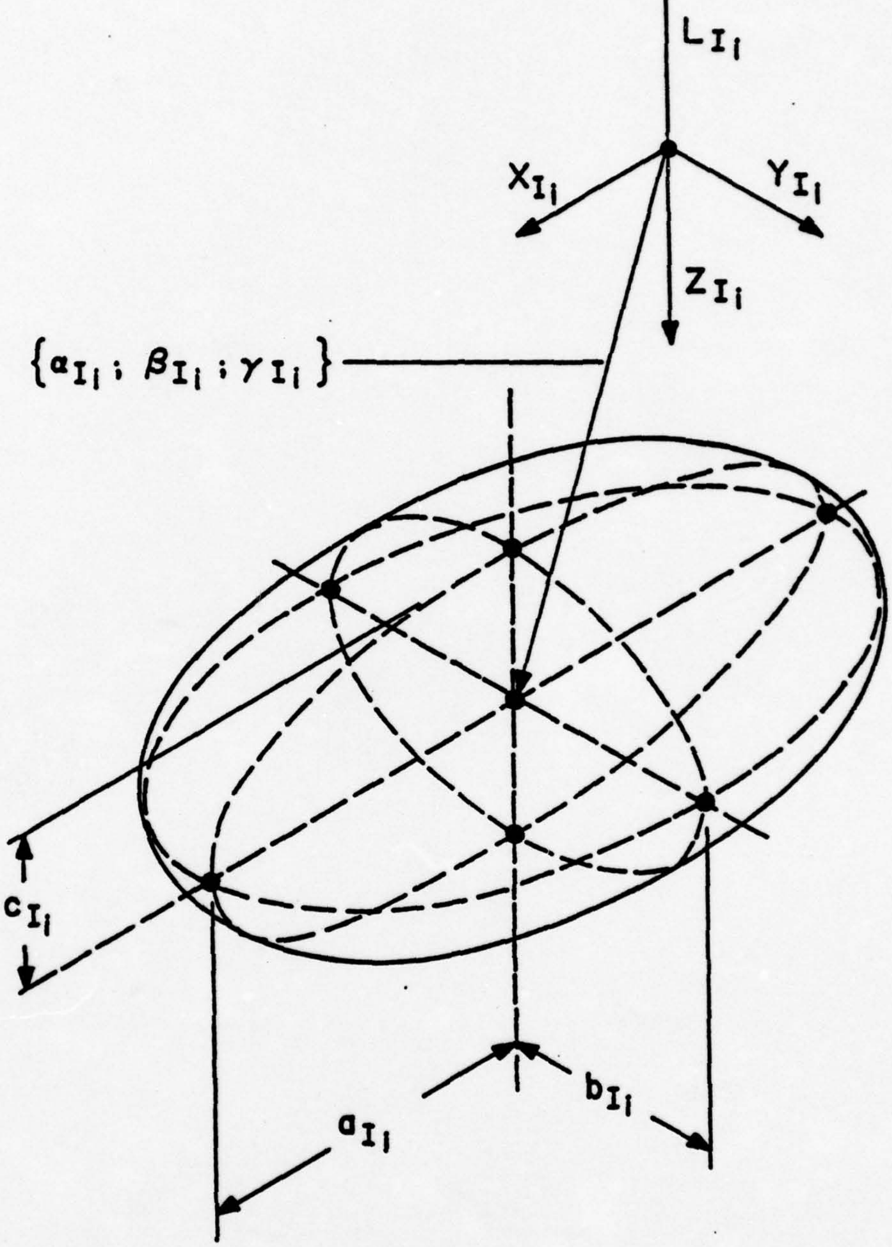


Figure 3. Ellipsoid Surrounding the Distal Joint of Link L_{I_i}.

axis of rotation. All ellipsoid axes are parallel to the axes of the link system of coordinates. This alignment produces a realistic contour of highly flexible joints at any degree of joint flexion or extension. The semiaxes a and c will have identical dimensions in most flexible joints. The cross sectional area of the ellipsoid in planes parallel to the z-x plane is thus circular. This enables the ellipsoid to function like a ball joint and to maintain anthropometrically realistic dimension in several directions.

The COMBIMAN man-model is displayed by projecting two orthogonal views on a cathode ray tube screen. The ellipsoids surrounding the joints are also projected into the screen. These projections are ellipses and are identical to the shadow of the ellipsoids produced by a source of parallel light perpendicular to the viewing screen. The man-model can be rotated and magnified or reduced within the viewing area. Any such manipulation changes the shape and/or size of the projected man-model. Any such manipulation will also change the shape and size of the shadow of a given ellipsoid on the cathode ray tube screen. The essence of the joint enfleshment stage is the definition of the projected ellipses under all conditions of body positions and viewing angles.

The projected contour of the ellipsoid onto a screen is identical to the crest (visible outer boundary) of the ellipsoid. The equations which have been developed by UDRI in conjunction with AMRL personnel are defined in detail in Section 2 of "The COMBIMAN Enfleshment Procedure and Expanded Joint Mobility Analysis", published as UDRI-TR-76-18, by the University of Dayton Research Institute in September, 1976.

The equations which are used to establish the lengths of the semiaxes a, b, and c for each joint, have not yet been validated against actual subject data. This, like the validation of the data used in stage one, is a key task to be accomplished during the next contract period.

2.1.3 Tangent Line Connectors

The last stage of the man-model generation is the connection of the elliptical contours of adjacent joints with tangent lines. This is done separately for all the contours in each viewing plane. Figure 4 shows a side view of the model with the tangent lines added. In this figure, unnecessary elliptical outlines have been eliminated. The present COMBIMAN program retains all outlines on the various views.

The equations used to establish the location of the endpoints of the tangent lines were developed by AMRL/HED personnel, in particular Dr. Joe McDaniel. The procedure used requires two sets of points which define the contours of two ellipses, each around a point of origin, with a link connecting them. One of the points of origin, and the set of points about it will be called proximal, and the other point will be called distal. From a point along the line passing thru the proximal and distal points, but beyond the proximal point, compute the slope of lines connecting this new point with each of the points on the distal ellipse. Locate the minimum and maximum slopes. From the point used in defining the maximum slope to the proximal projection, calculate the slopes to each point on the distal projection, and locate the minimum slope. From the first point used to define the first maximum slope, calculate the slope to each point on the proximal projection, and find the minimum slope. From the point used in defining this last minimum slope on the proximal projection, calculate the slopes to each point of the distal projection, and locate the maximum slope. A more detailed explanation of this procedure is shown in the flowchart in Figure 5.

The points which are located in steps 2 and 3, and 4 and 5 in Figure 5 define the endpoints of two tangent lines connecting adjacent links for one view of the model. This procedure is repeated for each combination of elliptical projections of adjacent links, for each view of the model.

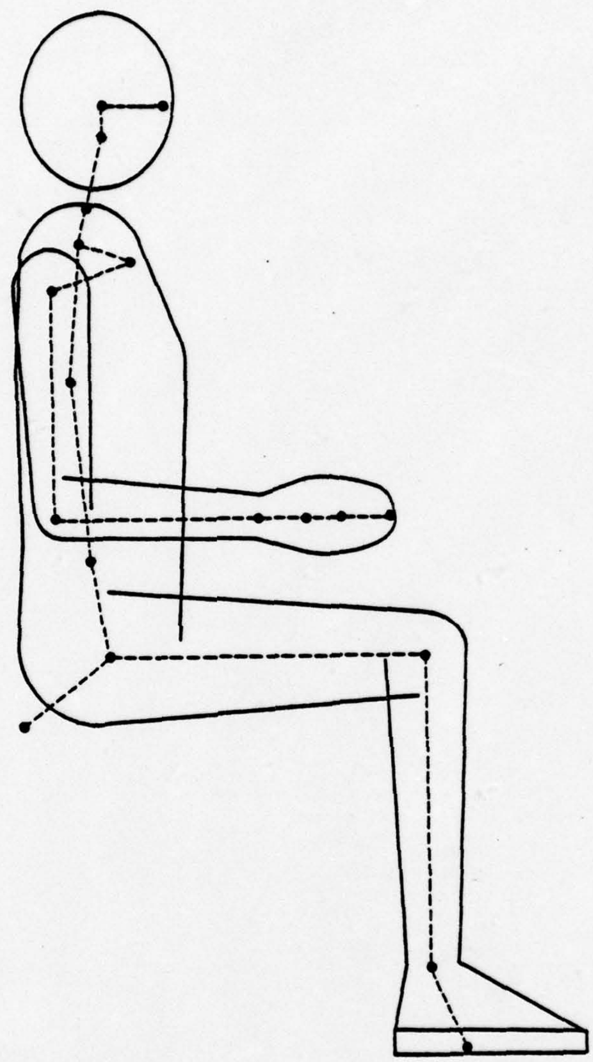


Figure 4. Side View of COMBIMAN With Tangent Lines (Reference 2).

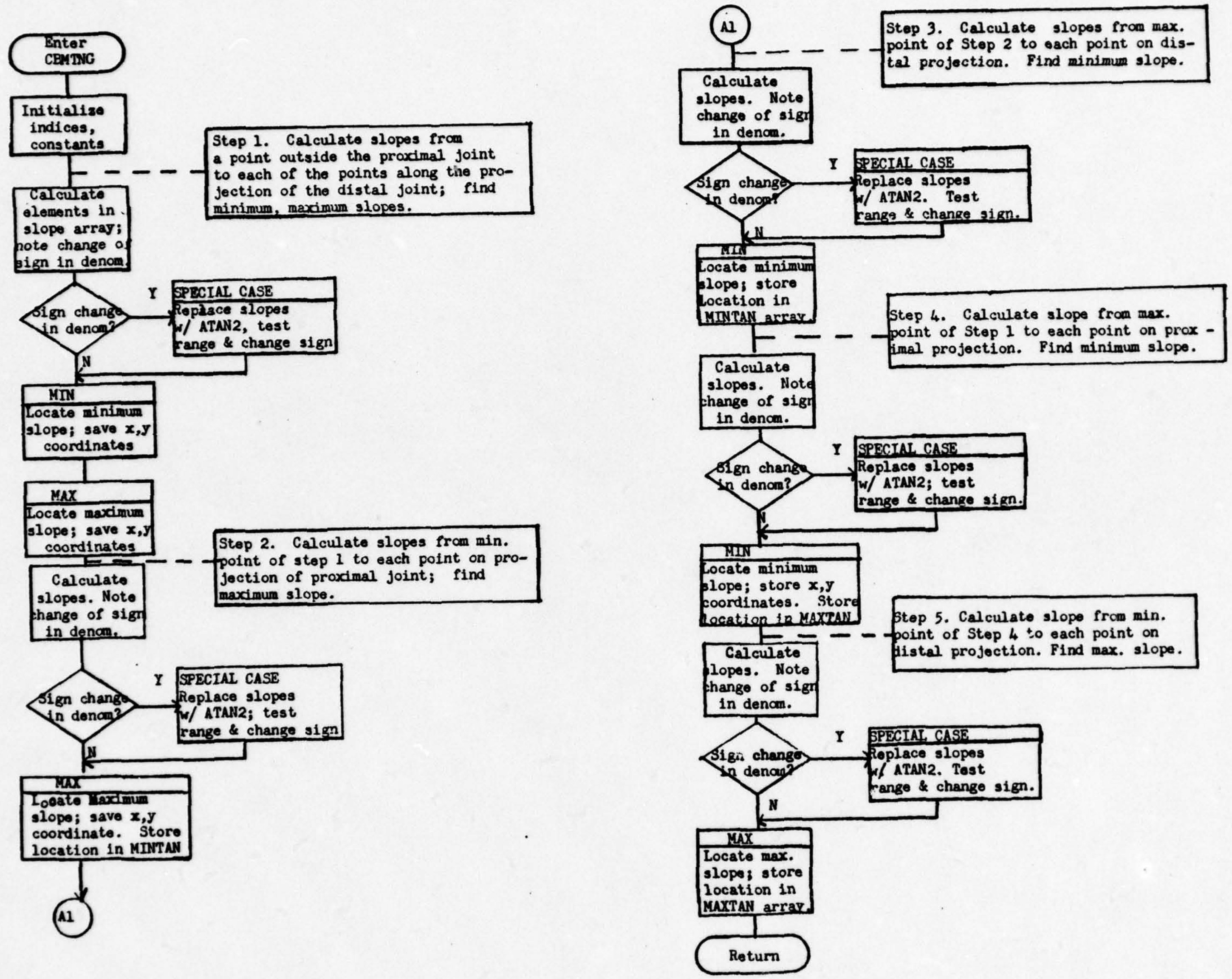


Figure 5. Flow of Tangent Line Subroutine.

Because of the nature of certain adjacent links, the enfleshment ellipses may appear to be concentric at certain viewing angles. Eventually, the tangent line subroutine will be able to detect this, and not calculate tangent line endpoints. At the present time, however, it attempts to calculate tangent lines, and often generates unusual results. An example of concentric ellipses in the side view is shown in Figure 6. The "tangent lines" connecting the MID-HIP projection and the RIGHT UPPER THIGH projection lay within the outer projection, creating unnecessary clutter on the display for the viewer.

The subroutine of the interactive graphics program CBM04, which issues the graphics orders to plot the man-model on the IBM 2250 CRT, uses the x, y, and z coordinates which define the endpoints of each link with respect to the SRP of the model. It uses the coordinates two at a time, however, to project the X-Z (side) plane, and the Y-Z (top) plane of the model (giving two orthogonal views). One view is completely generated, combining the link vertex data with the elliptical projection and tangent line coordinates for that view. The generation of and use of data for X-Y (top) plane is optional, but the user may decide to calculate this extra set of projectsions and tangent lines for use in hard copy - plots of the man-model/workspace configuration. The hard copy plots are discussed in the next paragraph.

2.2 PLOT COMBIMAN

In order to obtain hard-copy representations of the man-model and workstation configuration currently being displayed on the IBM 2250 Cathode Ray Tube (CRT), subroutines were developed and added to the COMBIMAN interactive graphics program CBM04 to generate two to three two dimensional plots on the HESS's on-line GOULD electrostatic plotter. The subroutines use the data arrays of three dimensional real world coordinates which are contained in computer memory and which represent the configuration of the link system of the model, the points on the elliptical projections, and the panels of the workstation. The subroutines also use data on the range of

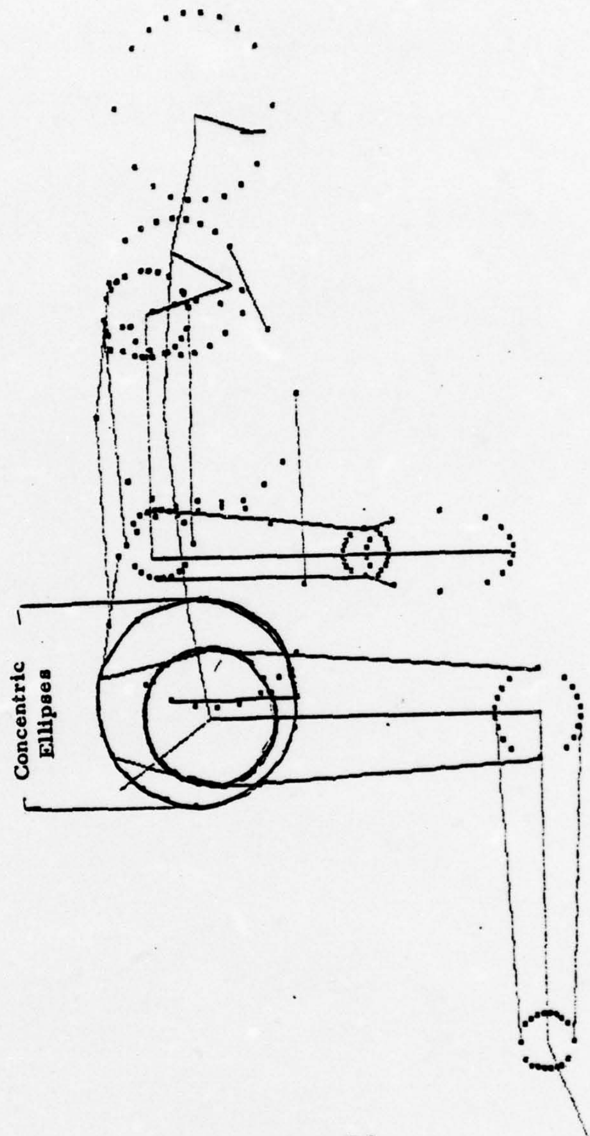


Figure 6. Side View of Model With Concentric Ellipses at Mid-Hip and Right Hip Identified.

x, y, and z-values contained in the arrays. These data were originally calculated by the subroutine which scales coordinate data to fit in the display area of the CRT and issues the graphics orders to generate the display. The range-data used include the maximum x, y, and z-coordinates found among the points, the ranges over x, y, and z-values, and the maximum of the three ranges.

2.2.1 Data Preparation

The user of the interactive graphics program has two options for specifying the size of the plots to be generated. The user can specify a scale factor from 0. to 1. or can omit any scale factor. For specific instructions on entering scale factors, see Paragraph 2.2.8 of the User's Guide for the Programs of COMBIMAN, AMRL-TR-76-117 (Reference 1). If no scale factor was supplied, the subroutine uses a factor which will scale the coordinates so as to make optimum use of a nine by nine inch plot area for each view. Once a scale factor has been established, the x-coordinates in the data arrays are scaled as follows:

NEWX = (R-WX - XMAX + (MAXDIF - XDIF)/2.0) * SCALE

where:

where:	NEWX	is the scaled x-coordinate value
	R-WX	is the unscaled x-coordinate value in the COMBIMAN base system of coordinates
	XMAX	is the maximum x-coordinate of all the coordinates in the x-coordinate data arrays
	MAXDIF	is the maximum range of coordinates in either the x, y, or z direction
	XDIF	is the difference between the minimum x-coordinate value and the maximum x-coordinate value
	SCALE	is the available scale factor

The y and z values are scaled similarly, using the following equations.

NEWY = (R-WY - YMAX - (MAXDIF - YDIF)/2.0) * SCALE

and

NEWZ = (R-WZ - ZMAX - (MAXDIF - ZDIF)/2.0) * SCALE

2.2.2 Plotting

Before the plots of the model and workstation are generated, the main subroutine prints the names of the anthropometric and regression survey used in generating the model, and the name of the workstation used, if one is being used on the plotter. From two to three plots are then generated of the two dimensional views of the model and workstation. The two views which will always be generated are of the X-Z plane and the Y-Z plane. If, prior to selecting the plot COMBIMAN function, the user selected State Switch 11, a third view of the X-Y plane will also be generated. A detailed description on setting State Switches is given in Paragraph 2.2.22 of the User's Guide (Reference 1). A general flow diagram of this main subroutine is shown in Figure 7. The actual plots are generated in a second plotter subroutine which calls the routines of the GOULD Plotter Package (see Reference 4), and plots the link system of the model, enfleshment projections, and the workstation panels for the view in question. A flow diagram of this second subroutine is shown in Figure 8. A complete plot, with three views of the model and workstation is shown in Figure 9.

2.3 GROUND VISIBILITY PLOTS

A subroutine has been added to the COMBIMAN interactive graphics program which enables the user to obtain ground visibility plots. The routine uses the eye location of the man-model in place of a camera lens, as used in AMRL-TR-69-123 (see Reference 5). The routine also provides the user with a cockpit visibility record. The boundary coordinates of objects to be plotted are obtained from engineering drawings of typical aircraft cockpits. The boundary coordinates, in the aircraft system, are read into the subroutine and first converted to the seat reference point coordinate system of the man-

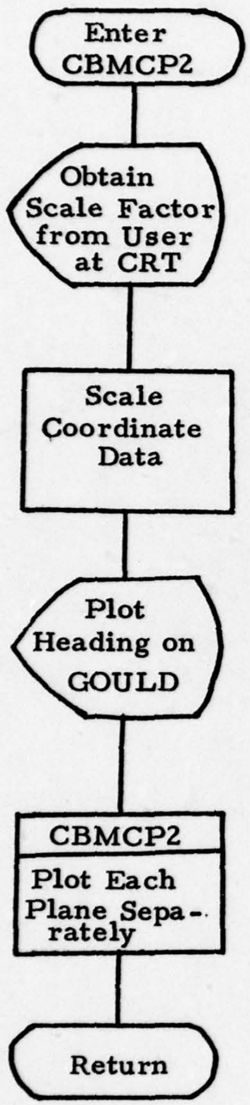


Figure 7. Flow Diagram for Subroutine CBMCP1.

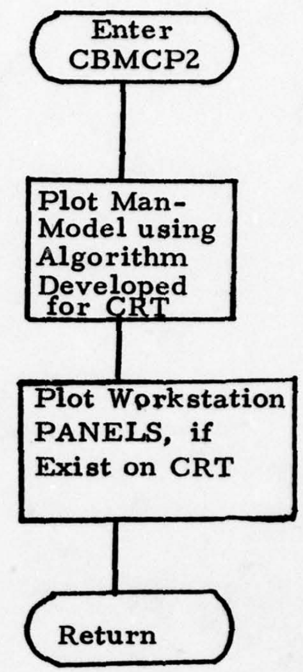


Figure 8. Flow Diagram for Subroutine CBMCP2.

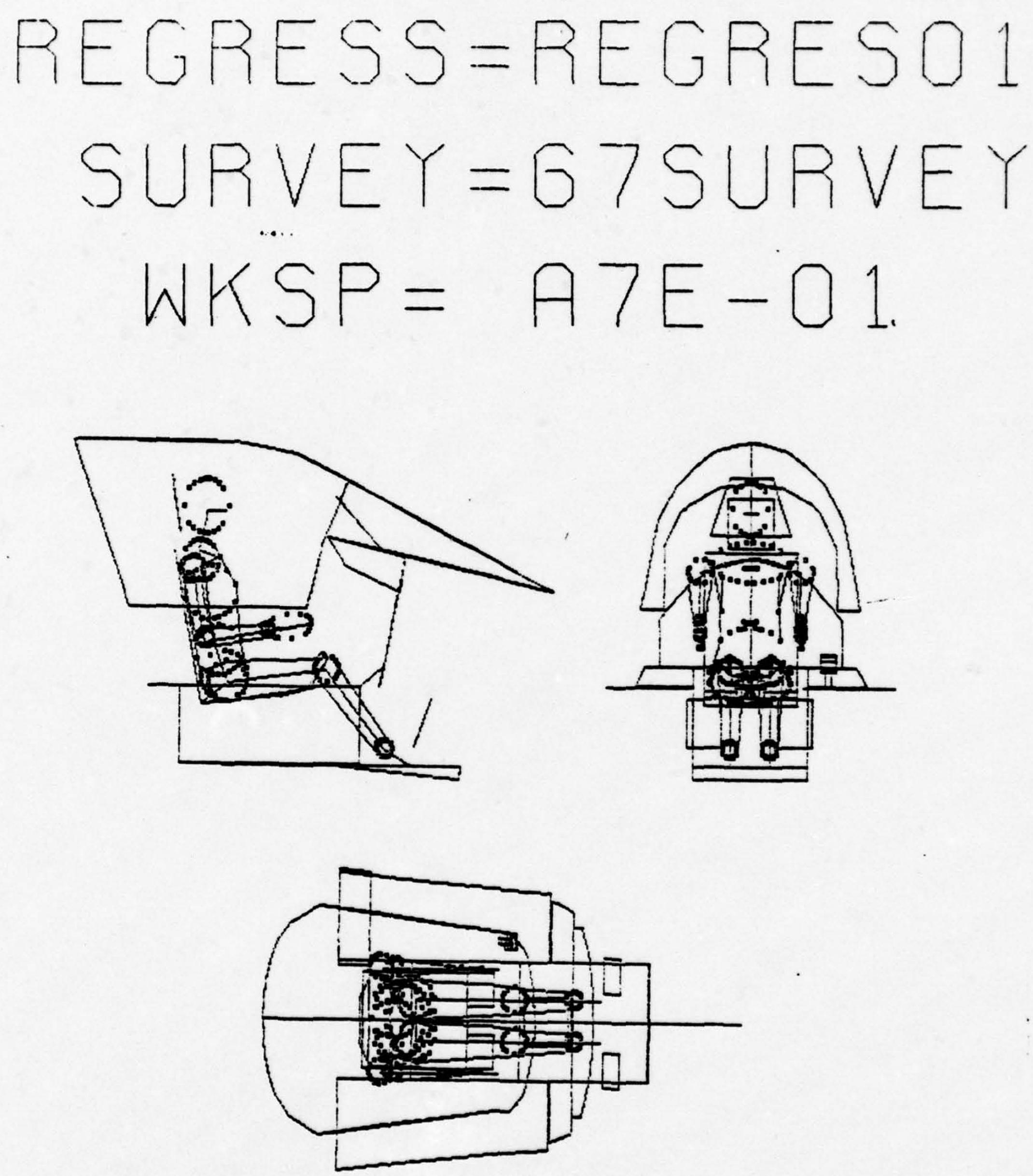


Figure 9. Sample Plot of Man-Model and Workstation from X-Z Y-Z and X-Y Planes.

model, and then to the eye coordinate system of the model, with either the mid-eye, right eye, or left eye point of the man-model being the new origin. The eye point used by the subroutine is determined by the user. The routine then calculates the viewing angle of the model with respect to horizontal and vertical, and uses these angles to establish the cockpit visibility records.

The Visibility Plot subroutine calculates the limits of the fields of vision of the present configuration of the model and superimposes these limits over the boundary coordinates of objects of an existing workspace. It then plots them both on an on-line GOULD plotter. At the present time, the workspace which is being used is that for the A7 cockpit.

As the necessary engineering drawings for more workspaces become available, more boundary coordinates can be typed onto computer cards and added to a special disk file and be made available to the user.

2.3.1 Workspace Outline Coordinate Data Input

Data for use by the visibility plot subroutine are originally obtained from engineering drawings. The three dimensional boundary coordinates of objects to be plotted, such as aircraft canopies, windscreens, and other key outlines, are obtained in the aircraft system of coordinates. The orientation of this system is shown in Figure 10. In addition to gathering coordinate data on the key boundaries in the workspace, the location of the neutral seat reference point in the aircraft coordinate system must also be obtained. When collecting points along the boundaries, it should be noted that the greater the number of points supplied to the subroutine, the smoother the plot will be. The maximum number of points allowed for any one boundary is 200.

Once the data are obtained from the engineering drawings, they should be punched onto computer cards using the formats shown in Figure 11. The first card is punched using the format in Figure 11a. This is done once for the complete set of workspace outlines being considered. The first field on the card, NBND, contains the number of boundaries to be contained in this visibility plot. This value is an integer value, and should be right justified in the five

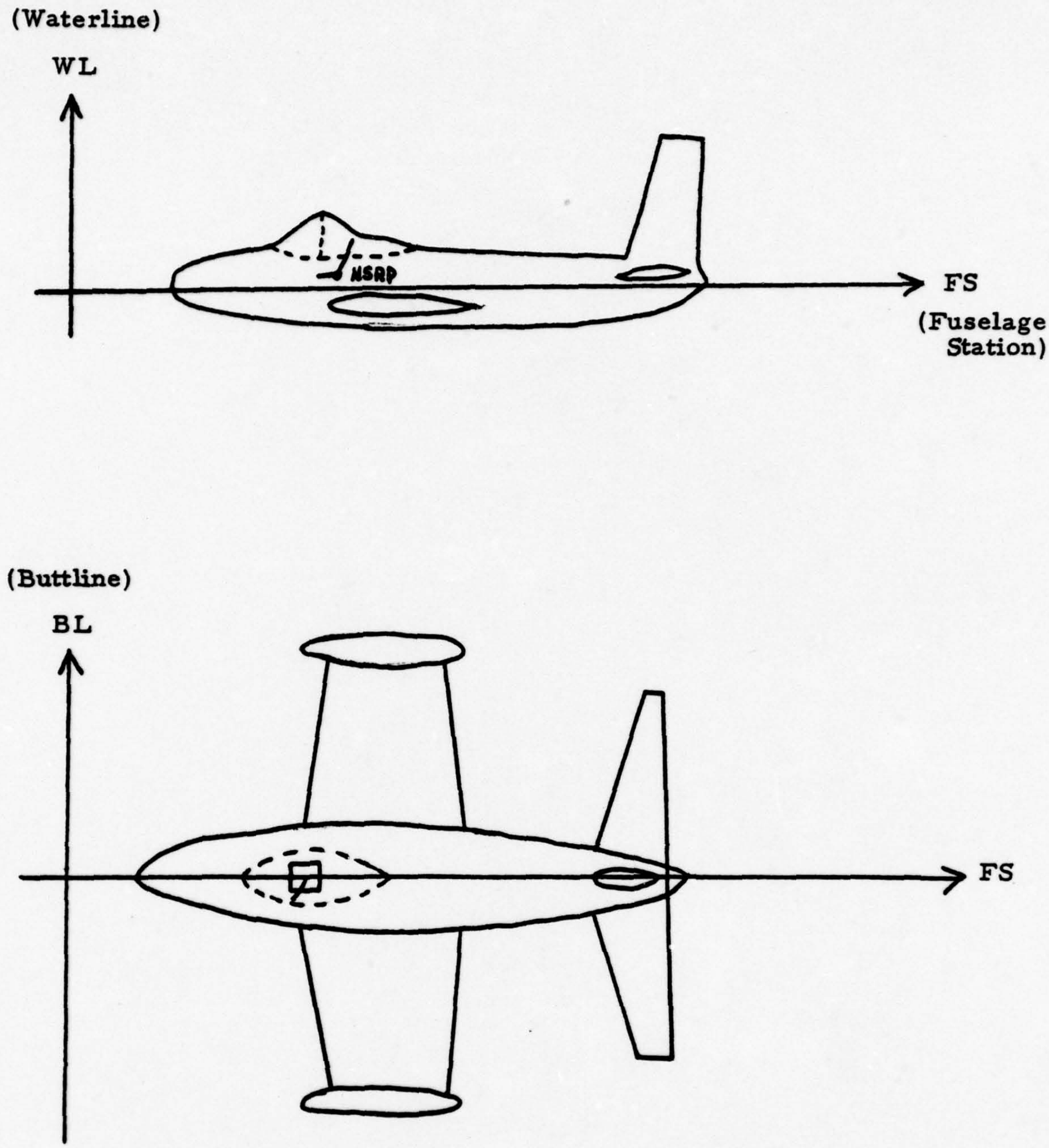


Figure 10. Orientation of Aircraft System of Coordinates.

IBM

INTERNATIONAL BUSINESS MACHINES CORPORATION

F[illegible] X24-6597-0
[illegible]ed in U.S.A.

MULTIPLE-CARD LAYOUT FORM

Company ______

Application ______ by ______ Date ______ Job No. ______ Sheet No. ______

NBND	XAC	YAC	ZAC	XC	YC	ZC	
1–5	6–10	11–15	16–20	21–25	26–30	31–35	36–80

(a) Visibility Plot Control Card Format.

NCOORD	BOUNDARY NAME	
1–5	6–29	30–80

XCOORD	YCOORD	ZCOORD	
1–6	7–12	13–18	19–80

(b) Boundary Definition Card Format.
(c) Boundary Points Card Format.

Figure 11. Input Formats for Visibility Plot Subroutine.

digit field. The next three fields (XAC, YAC, ZAC) define the location of the neutral seat reference point in the aircraft system of coordinates. These coordinates are real values and assume a format of F5.3 if no decimal point is supplied by the user. The last three fields of this card define the location of the seat reference point of the COMBIMAN model with respect to the neutral seat reference point of the aircraft. At the present time these values should be zero or left blank. In the near future they will be obtained from the interactive graphics program CBM04 to reflect variations in the location of the seat with respect to the original neutral seat reference point.

The second and third formats shown in Figure 11 are used for each boundary. The format in Figure 11b contains the number of coordinate sets, NCOORD, which will be used to define this boundary. It is an integer value, and should be right justified in the five digit field. This card also contains an alphanumeric name for the boundary in field BOUNDARY NAME. The name may not be more than 24 characters long. The format shown in Figure 11c is used to define the three coordinates for each point along the boundary. The three coordinates are to be supplied in the aircraft system, and are typed using a F6.2 format. Sample coordinate data for the A7 cockpit is shown in Figure 12. The workspace is defined in terms of three configurations, the Front Bottom Windscreen, the Front Top Windscreen, and the Cockpit Canopy Clearline.

Once all the data have been punched onto computer cards, they are written onto a disk file for use by the interactive graphics program CBM04. The Job Control Cards (JCL) for accomplishing this are shown in Figure 13. The first outlined area in Figure 13 lists the JCL needed to call an IBM utility "IEHPROGM" which scratches any dataset containing workspace boundary data which may exist on disk. The second outline area shows the JCL needed to call the IBM utility "IEBGENER" and create a new dataset called "SME. VISDATA" which will contain the boundary coordinate data available on cards. The third outlined area lists the JCL used to call the IBM utility "IEBGENER"

```
  3270.6  0.099.15  0.0  0.0  0.0
 17WINDSCREEN, FRNT BOTTOM
22763    544 12535                      101
22379    551 12324                      101
22098    546 12157                      101
21893    519 12059                      101
21579    486 11876                      102
21314    427 11735                      102
21109    362 11616                      102
20914    281 11584                      102
20914    000 11584                      103
20914   -281 11584                      103
21109   -362 11616                      103
21314   -427 11735                      103
21579   -487 11876                      104
21893   -519 12059                      104
22098   -546 12157                      104
22379   -551 12324                      104
22763   -584 12535
 17WINDSCREEN, FRONT TOP
22763    584 12535
23000    578 12665                      201
23212    568 12784                      201
23444    541 12903                      201
23731    470 13059                      202
23941    405 13173                      202
24109    292 13286                      202
24212    200 13341                      202
24212    000 13341                      203
24212   -200 13341                      203
24109   -292 13286                      203
23941   -405 13173                      203
23731   -470 13059                      204
23444   -541 12901                      204
23212   -568 12784                      204
23000   -578 12665
22763   -584 12535                      205
 92COCKPIT CANOPY CLEARLINE
29447    000 13550
29404    247 13460                      301
29361    622 13326                      301
29322    832 13201                      301
29261   1054 13024                      302
29209   1243 12860                      302
29162   1378 12700                      302
29114   1503 12557                      302
29067   1589 12415                      303
29002   1730 12238                      303
28959   1805 12086                      303
28907   1886 11944                      303
28855   1951 11832                      304
28795   1946 11771                      304
28743   1946 11732                      304
28678   1941 11698                      304
28596   1930 11676                      305
28471   1930 11659                      305
28281   1914 11641                      305
28134   1908 11629                      305
27987   1897 11616                      306
27767   1886 11594                      306
27572   1865 11577                      306
27335   1849 11555                      306
27080   1838 11533                      307
26894   1882 11516
26713   1800 11499                      307
26497   1789 11486                      307
26073   1751 11442                      308
25853   1724 11425                      308
25559   1703 11430                      308
25469   1697 11460                      309
25292   1578 11577                      309
25192   1470 11745                      309
25132   1389 11857                      310
25067   1335 11970                      310
25067   1335 11970                      310
24955   1178 12238                      310
24907   1097 12430                      311
24873   1016 12550
24821    881 12700                      311
24782    784 12850                      311
24743    632 13000                      312
24708    497 13200
24678    281 13450                      312
24661    000 13500                      312
24678   -281 13450                      313
24708   -497 13200                      313
24743   -632 13000                      313
24782   -784 12850                      313
24821   -881 12700                      314
24873  -1016 12550                      314
24907  -1097 12430                      314
24955  -1178 12238                      314
25067  -1335 11970                      315
25132  -1389 11857                      315
25192  -1470 11745                      315
25291  -1578 11577                      316
25469  -1697 11460                      316
25559  -1703 11430                      316
25711  -1719 11413                      317
25853  -1724 11425                      317
26073  -1751 11443                      317
26272  -1773 11464                      317
26477  -1789 11486                      318
26713  -1800 11499                      318
26894  -1822 11516                      318
27080  -1838 11533                      318
27335  -1849 11555                      319
27572  -1865 11577                      319
27767  -1886 11594                      319
27987  -1897 11616                      319
28134  -1908 11628                      320
28281  -1914 11641                      320
28471  -1930 11659                      320
28596  -1930 11676                      320
28678  -1941 11698                      321
28743  -1946 11732                      321
28795  -1946 11732                      321
28855  -1951 11832                      321
28907  -1886 11944                      322
28959  -1805 12086                      322
29002  -1730 12238                      322
29067  -1589 12415                      322
29114  -1503 12557                      323
29162  -1378 12700                      323
29209  -1243 12858                      323
29261  -1054 13024                      323
29322  - 832 13201                      324
29361  - 622 13326                      324
29404  - 247 13460                      324
29447    000 13550
```

Figure 12. Punched Data for A7 Cockpit Boundary.

```
//VISFILE  JOB (UDR807,KO),EVANS,MSGLEVEL=1
//SCRATCH EXEC PGM=IEHPROGM
//SYSPRINT DD DUMMY
//PUBLIC DD VOL=SER=PUBLIC,UNIT=3330,DISP=OLD                        1
//SYSIN DD *
 SCRATCH DSNAME=SME.VISDATA,VOL=3330=PUBLIC
/*
//RECRT EXEC PGM=IEBGENER
//SYSUT2 DD DSN=SME.VISDATA,DISP=(NEW,CATLG),UNIT=SYSDA,
//          VOL=SER=PUBLIC,SPACE=(1600,(10,5),RLSE),
//          DCB=(LRECL=80,RECFM=FB,BLKSIZE=1600,DSORG=PS)
//SYSPRINT DD SYSOUT=A,DCB=BLKSIZE=121
//SYSIN DD DUMMY
//SYSUT1 DD *
                                                                     2
     BOUNDARY OUTLINE CARDS GO HERE

/*
//PRINT EXEC PGM=IEBGENER
//SYSUT1 DD DSN=SME.VISDATA,DISP=OLD
//SYSPRINT DD SYSOUT=A,DCB=BLKSIZE=121                               3
//SYSUT2 DD SYSOUT=A,DCB=BLKSIZE=81
//SYSIN DD DUMMY
/*
//
```

Figure 13. Job Control Cards Needed to Establish Data Set on Disk Containing Boundary Outlines for Visibility Plots.

again, but this time it prints the contents of the dataset "SME. VISDATA" for verification purposes. A detailed description of each of the IBM utilities used can be found in Reference 6.

Although the boundaries are described separately on computer cards, the individual subsections are automatically recombined before plotting the total visibility plot.

2.3.2 Generating the Vision Angles

The subroutine to generate the visibility plot is activated when the user of the interactive graphics program CBM04 presses the Visibility Plot Function Key (see Reference 1). This subroutine then reads the disk file which has been loaded with workspace boundary coordinates, and stores the available data for the necessary calculations in arrays in memory. If, for some reason, the disk file does not contain any workspace coordinate data, the message "NO DATA AVAILABLE FOR VISIBILITY PLOT ON UNIT 9" will be displayed in the information area of the screen. The routine is ended and the user is asked to depress another function eky.

Once the function key has been depressed and the boundaries read in, the prompting area will display the message "ENTER EYE LOCATION (LINK)". The user must decide on the eye point to be used as a reference for the plots. Possible values are either 8 for Mid-Eye point, 9 for Right Eye point or 10 for the Left Eye point. These values should be typed in, right justified in the eight digit field. Once a valid link number has been specified, the message "PLOTTING" is displayed on the CRT screen.

The routine uses the coordinates which define the endpoint of the Mid-Head link (link 7) and the coordinates of the Mid-Eye point to calculate the angles of sight from horizontal and from vertical. Facing forward and looking straight ahead would be angle of 0° from both horizontal and vertical.

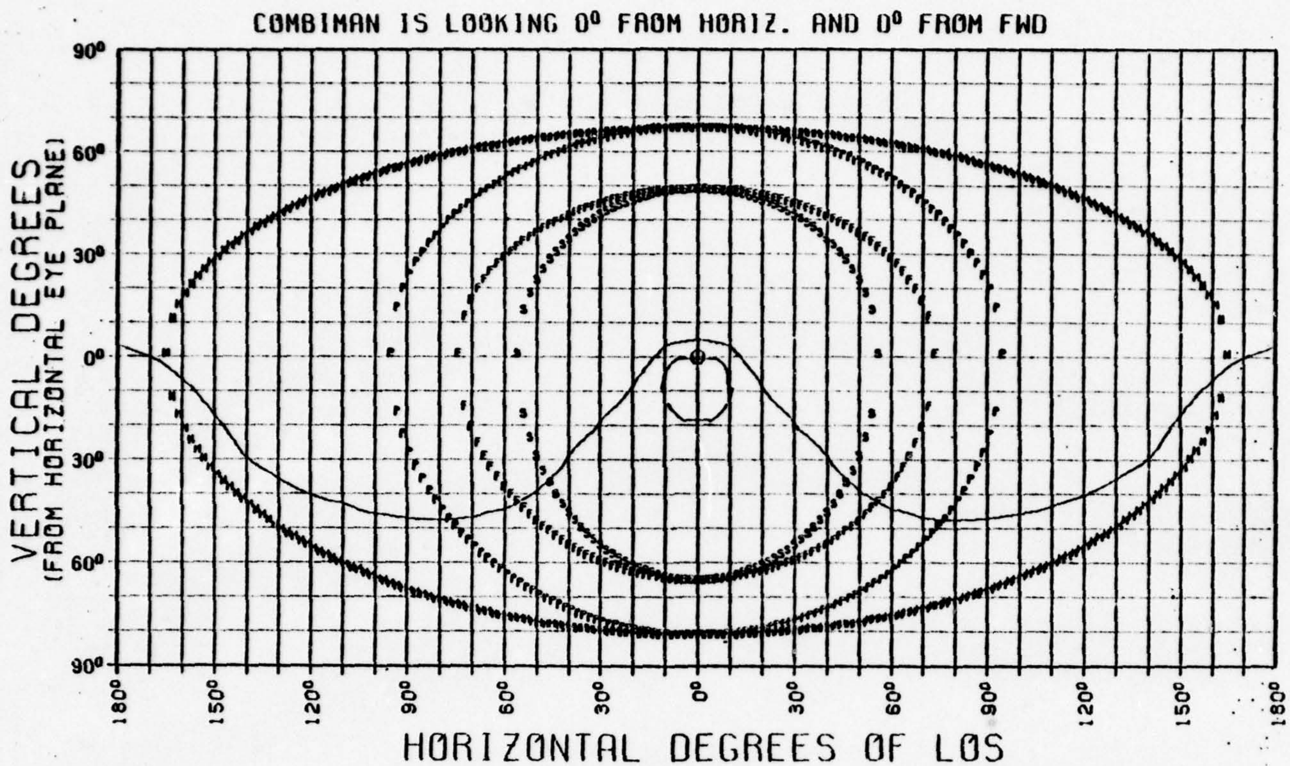


Figure 14. Sample Visibility Plot - Straight Ahead View.

Once the three dimensional coordinates of the boundary have been translated to the eye coordinate system of the model, the subroutine processes the points by iterating over the angular range of the points to determine the intersection of integer angles of horizontal line of sight with the line segment formed by two consecutive points on the workspace boundary. The angular range of points is calculated by the subroutine, and is based on the minimum and maximum horizontal angle of intersection with the workspace boundary being evaluated. The equations which are used to establish the angles of intersection and the coordinates of the boundary at these points were provided by Dr. McDaniel of AMRL.

2.3.3 The Visibility Plot And Printed Output

Figure 14 shows a sample visibility plot with the A7 outline. For this example, the man-model was positioned in a seated erect posutre, looking straight ahead. The vision limits were generated with respect to the angle of sight of the Mid-Eye point (link 8).

The four ellipses on the plot define the limits of various visual fields. The inner most field, plotted with the letter S, defines the field of stereo vision, with both eyes in their normal position. The next field, plotted with the letter F, defines the right and left fixation limits of vision. The third field is plotted with the letter P and defines the limits of peripheral vision associated with the facing forward with respect to the head. The outer-most field, plotted with the letter M, defines the maximum peripheral vision limits for the left and right eye. The symbol ⊕ defines the normal line-of-sight of the model.

The contour of the workspace boundaries are plotted with respect to the line-of-sight of the man model. As the model's head is shifted from the foward position the workspace boundaries are shifted in the opposite direction. An angle other than zero degrees from the horizontal eye plane of the model causes the boundaries to be raised or lowered based on a positive or negative angle from horizontal. The label indicating degrees on the vertical axis is

shifted in increments of multiples of ten degrees. This increment is calculated by dividing the angle from horizontal by 10., truncating this quotient to the nearest whole number, and then multiplying this value by 10. The boundaries and the visual limits are shifted slightly, so that value obtained with respect to the vertical axis is always labeled with angles which are multiples of 10. A sample visibility plot which was generated using visual angles of -15° from horizontal and 30° from forward is shown in Figure 15.

In addition to generating a hard copy plot on the GOULD unit, the subroutine also calculates and sends to the printer the three dimensional coordinates of each of the workspace boundaries in five degree angle increments from -180° from horizontal line of sight to +180°. The coordinates are given in the aircraft system of coordinates. The listing also gives the coordinate of the eye location in the aircraft system. Figure 16 shows the coordinate data for the plot in Figure 14.

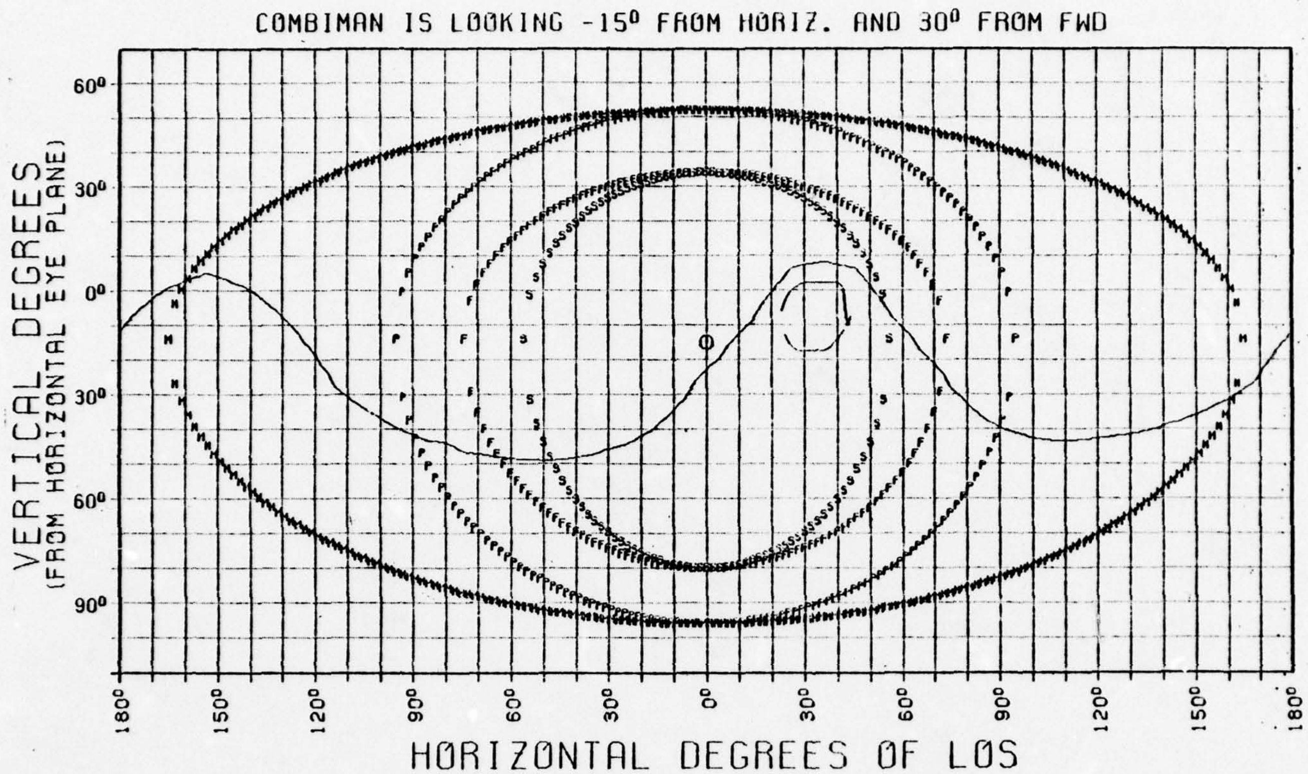


Figure 15. Sample Visibility Plot - Off Angle View.

CBM04 --- COMBIMAN PROGRAM, VERSION 4

VISIBILITY PLOT DATA FOR COCKPIT CANOPY CLEARLINE

EYE LOCATION IN AIRCRAFT SYSTEM (262.26, 0.0 ,133.58)

HORIZ.	AIRCRAFT COORDINATES			HORIZ.	AIRCRAFT COORDINATES			HORIZ.	AIRCRAFT COORDINATES		
ANGLE	FS	BL	WL	ANGLE	FS	BL	WL	ANGLE	FS	BL	WL
-180	294.470	-0.000	135.500	-60	253.086	15.891	115.660	60	253.083	-15.896	115.656
-175	294.004	2.777	134.490	-55	251.947	14.729	117.404	65	254.429	-16.795	114.772
-170	293.688	5.541	133.502	-50	250.899	13.540	119.302	70	256.045	-17.078	114.249
-165	293.224	8.297	132.024	-45	249.938	12.323	121.453	75	257.649	-17.209	114.176
-160	292.483	11.000	129.841	-40	249.109	11.036	124.144	80	259.206	-17.323	114.305
-155	291.646	13.703	127.091	-35	248.522	9.620	126.100	85	260.729	-17.510	114.430
-150	290.483	16.294	123.642	-30	247.982	8.244	127.876	90	262.261	-17.679	114.592
-145	289.109	18.799	119.546	-25	247.567	6.852	129.475	95	263.819	-17.816	114.758
-140	285.261	19.300	116.665	-20	247.212	5.477	131.248	100	265.420	-17.920	114.896
-135	281.341	19.080	116.290	-15	246.959	4.100	133.007	105	267.083	-17.998	114.987
-130	278.104	18.882	115.983	-10	246.775	2.731	134.514	110	268.890	-18.214	115.155
-125	275.300	18.622	115.731	-5	246.692	1.362	134.758	115	270.832	-18.381	115.333
-120	272.925	18.472	115.513	0	277.911	0.0	135.000	120	272.925	-18.472	115.513
-115	270.832	18.381	115.333	5	246.692	-1.362	134.758	125	275.300	-18.622	115.731
-110	269.097	18.783	115.174	10	246.775	-2.731	134.514	130	278.104	-18.882	115.983
-105	267.083	17.998	114.987	15	246.959	-4.100	133.007	135	281.341	-19.080	116.280
-100	265.419	17.913	114.887	20	247.212	-5.477	131.248	140	285.261	-19.300	116.665
-95	263.817	17.787	114.740	25	247.567	-6.852	129.475	145	289.109	-18.799	119.546
-90	262.261	17.647	114.579	30	247.982	-8.244	127.876	150	290.483	-16.294	123.642
-85	260.729	17.510	114.420	35	248.522	-9.620	126.100	155	291.646	-13.703	127.090
-80	259.206	17.323	114.302	40	249.109	-11.036	124.144	160	292.483	-11.000	129.836
-75	257.658	17.178	114.265	45	249.938	-12.323	121.453	165	293.224	-8.297	132.024
-70	256.050	17.063	114.292	50	250.899	-13.540	119.302	170	293.688	-5.541	133.502
-65	254.429	16.795	114.772	55	251.947	-14.729	117.404	175	293.986	-2.776	134.489

Figure 16. Sample Visibility Plot Printed Output for Cockpit Clearline Boundary in Figure 14.

SECTION 3
STRENGTH CAPABILITIES OF SEATED OPERATORS

The University of Dayton Research Institute supported a study to determine the capabilities of human subjects to exert forces on a triaxial force handle located within the subjects' reach. This study is being conducted by Dr. J. W. McDaniel of AMRL/HED. UDRI personnel performed modification, calibration, and maintenance of the HERCULES (Human Engineering Research to Cull Efficient Strength) apparatus located in AMRL/HED. UDRI personnel were also responsible for the collection of strength data from human subjects and the preliminary data analysis.

3.1 HERCULES LAB

The HERCULES apparatus and associated equipment has been made completely operational after a period of inactivity. Using a triaxial strain gauge transducer handle, this system can measure and record forces exerted by seated human subjects with 2% accuracy on forces up to 300 pounds in any direction. The handle was positioned in 76 locations relative to the SRP (Seat Reference Point) of the seated subject.

The equipment used for the data collection is shown in Figure 17 and consists of the triaxial force handle, a Honeywell Accudata 113 bridge amplifier system, a Honeywell 5600B 7-channel FM tape recorder, a Brush Mark 200 strip chart recorder, an audio amplifier and power supply, and a remote control unit.

3.1.1 Contractor-Built Equipment

3.1.1.1 Remote Control Unit

To simplify the experimenter's task, a remote control unit (shown in Figure 18) was designed and built to contain an exertion timer, dial encoder, strip chart ON/OFF switch, data switch, and tape

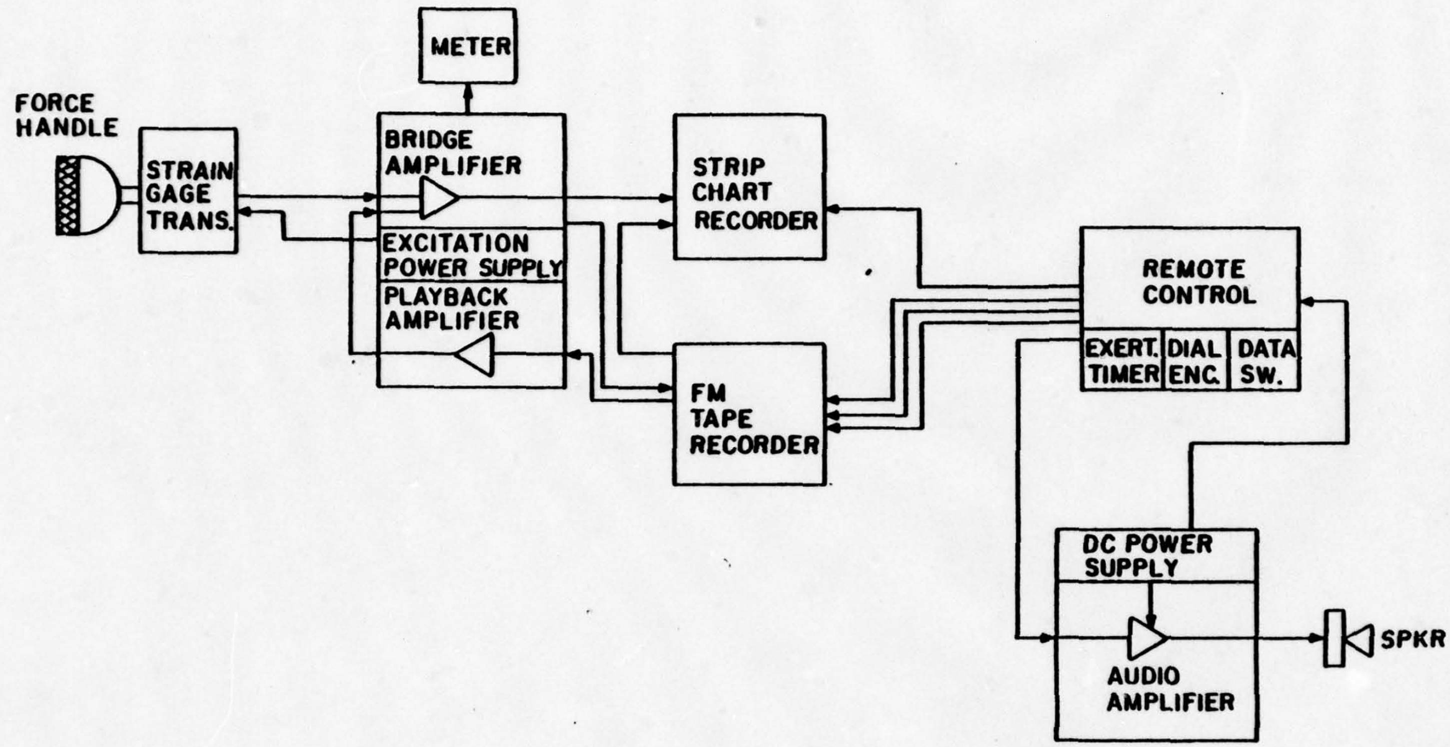


Figure 17. HERCULES System Component Diagram.

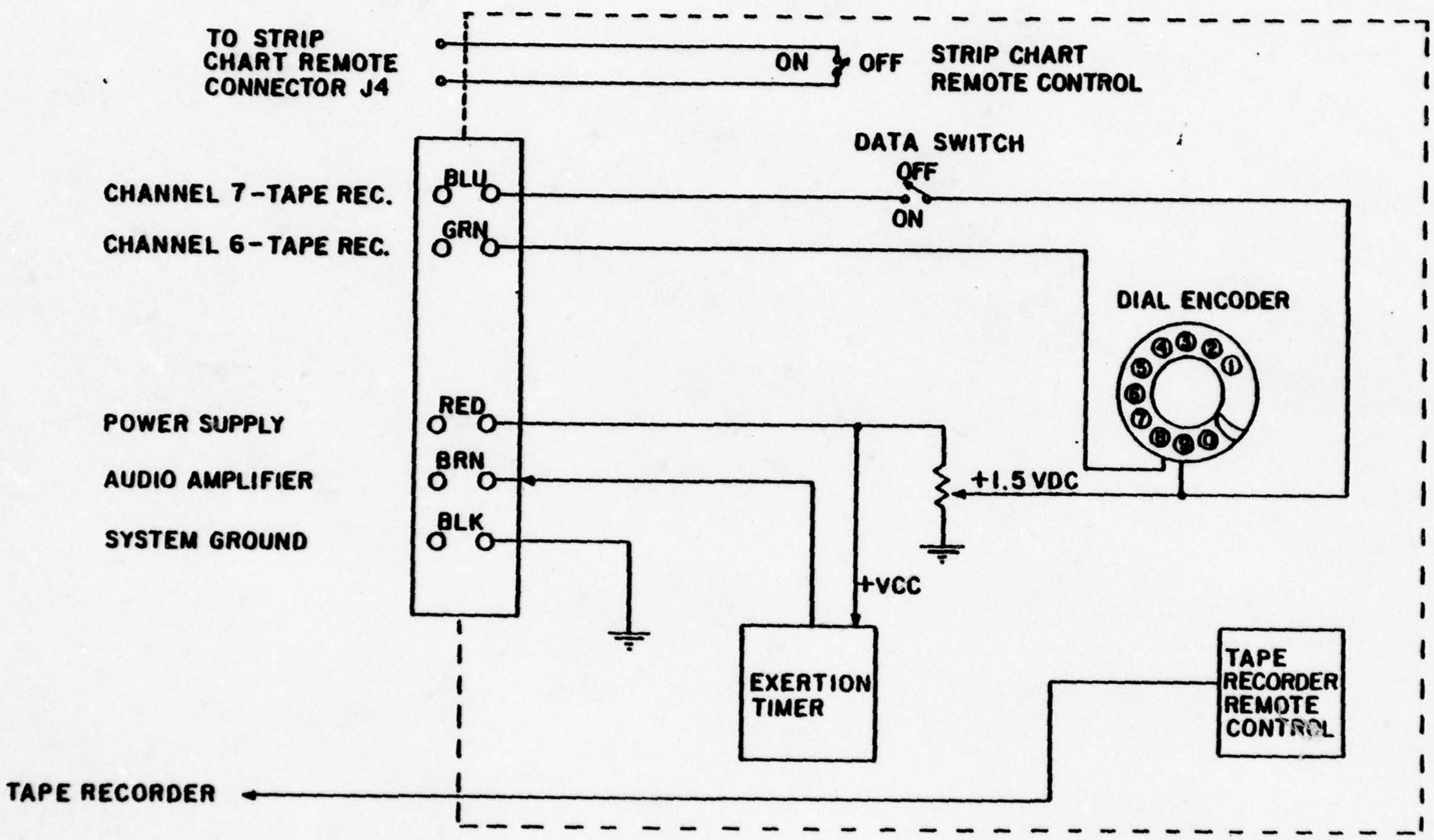


Figure 18. HERCULES System Remote Control Unit.

recorder remote control. These functions were connected to the system with a ten-foot cable. The controls on the panel were arranged according to order and frequency of use. This arrangement places all frequently used functions at the experimenter's fingertips.

To provide an edit function, a data switch was installed on the remote control unit and was used to indicate valid (ON) or invalid (OFF) data on one channel of the tape recorder.

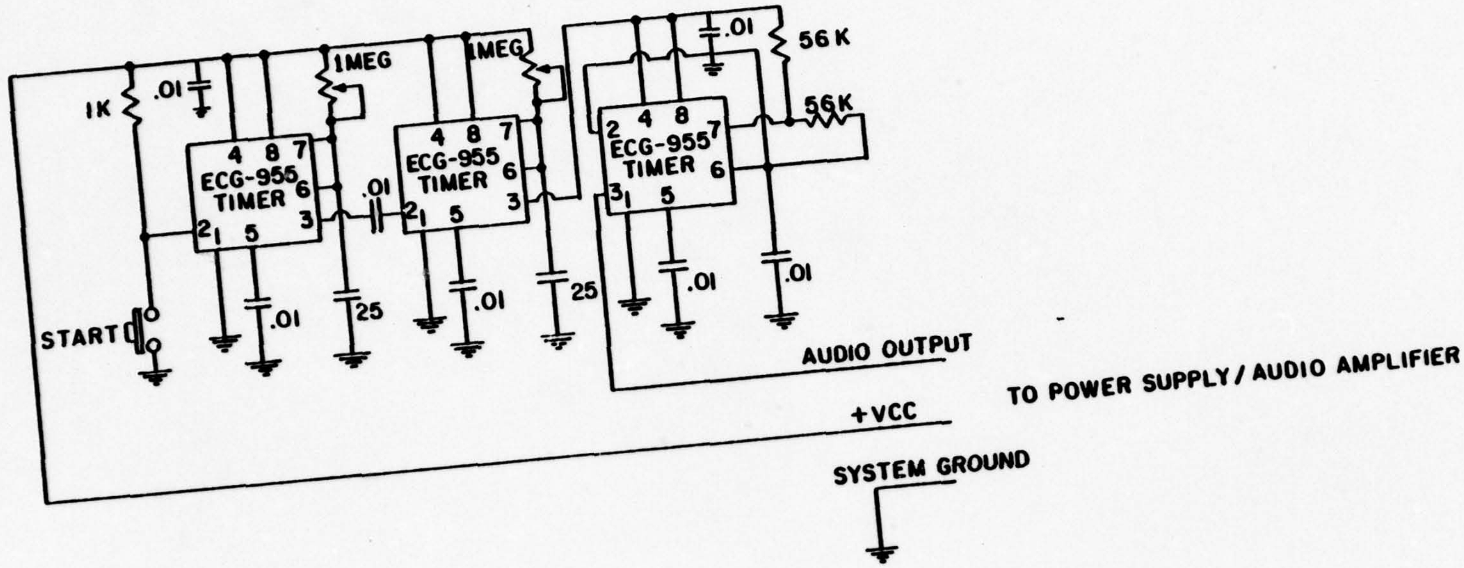
3.1.1.2 Timer Controlled Tone Generator

An electronic timer was designed and constructed to provide an auditory tone to cue the subject as to when to terminate the exertion. The timer consisted of three ECG-955 ICs (integrated circuits) performing three basic functions within the timer. The circuit diagram is shown in Figure 19.

IC1 was triggered by a pushbutton at the beginning of a force exertion and performed the main timing function of controlling the delay interval. This interval was adjustable from zero to two minutes but was normally set to five seconds. Triggered by IC1, IC2 controlled the duration of the auditory tone and was also variable from zero to 2 minutes in length, but was normally set to a $\frac{1}{2}$ second burst. IC3 was used as an audio oscillator and was turned on and off by IC2. The output of IC3 was connected to the input of the audio amplifier as shown in Figure 20.

3.1.1.3 Audio Amplifier

The audio amplifier was on LM380 IC capable of one watt audio output and was normally set well below this level. The audio output was coupled to a common speaker. The speaker was attached to the HERCULES handle mainframe assembly near the subject.



ALL CAPACITORS IN μfd

Figure 19. Circuit Diagram for Electronic Timer.

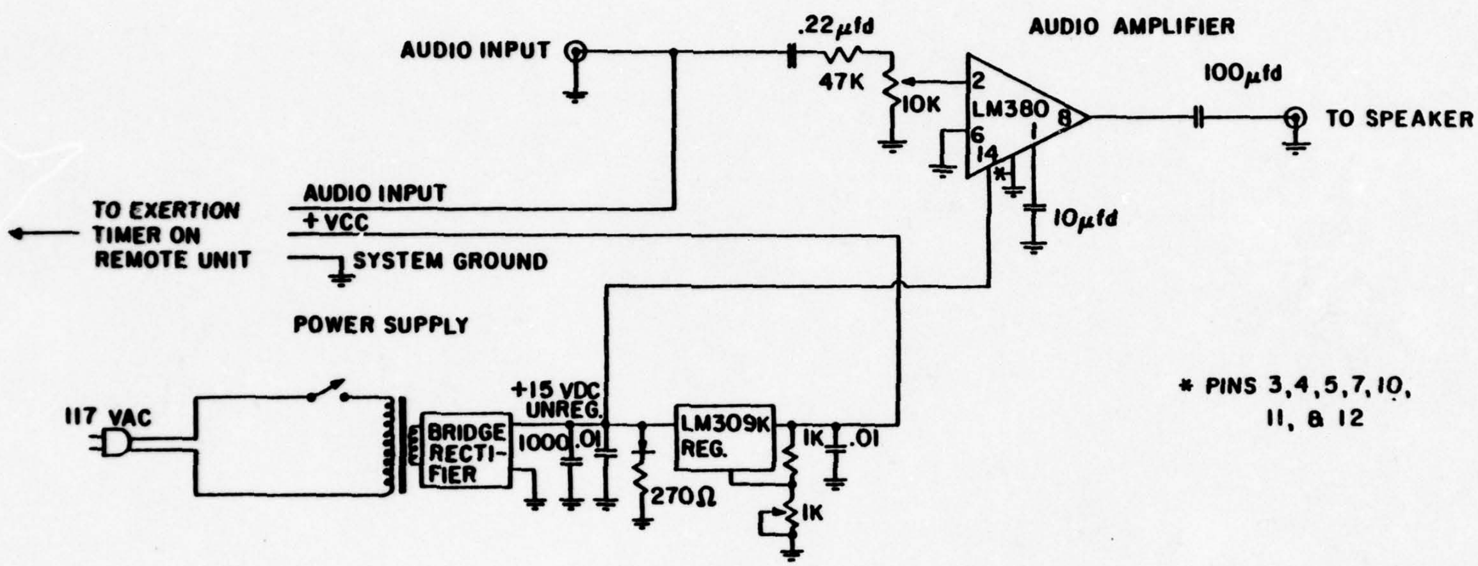


Figure 20. Diagram of the Power Supply and Audio Amplifier.

3.1.1.4 Power Supply

A power supply was built for the timer, audio amplifier, data switch, and dial encoder and is shown in Figure 20. Using an LM309K voltage regulator IC, the supply is adjustable from five to fifteen volts DC at up to 1 amp output current with internal overload protection.

3.1.2 Modifications to the Existing Equipment

3.1.2.1 Reference Resistors

The accuracy of the system has been improved through various modifications. Calibration efficiency required high-stability reference potentiometers as shown in Figure 21 , to be installed and calibrated to simulate known forces in six directions. A weight stand was build to facilitate applying known forces on the handle. Its pulley system allowed a 100-pound force to be exerted on the handle in six orthogonal directions. A digital voltmeter was used to calibrate the reference potentiometers against the 100-pound weights.

3.1.2.2 Noise Level Reduction

The system originally had a high noise level due to several unshielded connections. When these were corrected, the noise was reduced significantly.

3.1.2.3 Dial Encoder

A telephone-type dial encoder was used to generate pulses to identify calibrations, subjects, and handle positions during data collection. This was installed on the remote control unit.

3.1.2.4 Tape Recorder Remote Control

This unit was installed on the remote control unit. However, there were no further modifications to it.

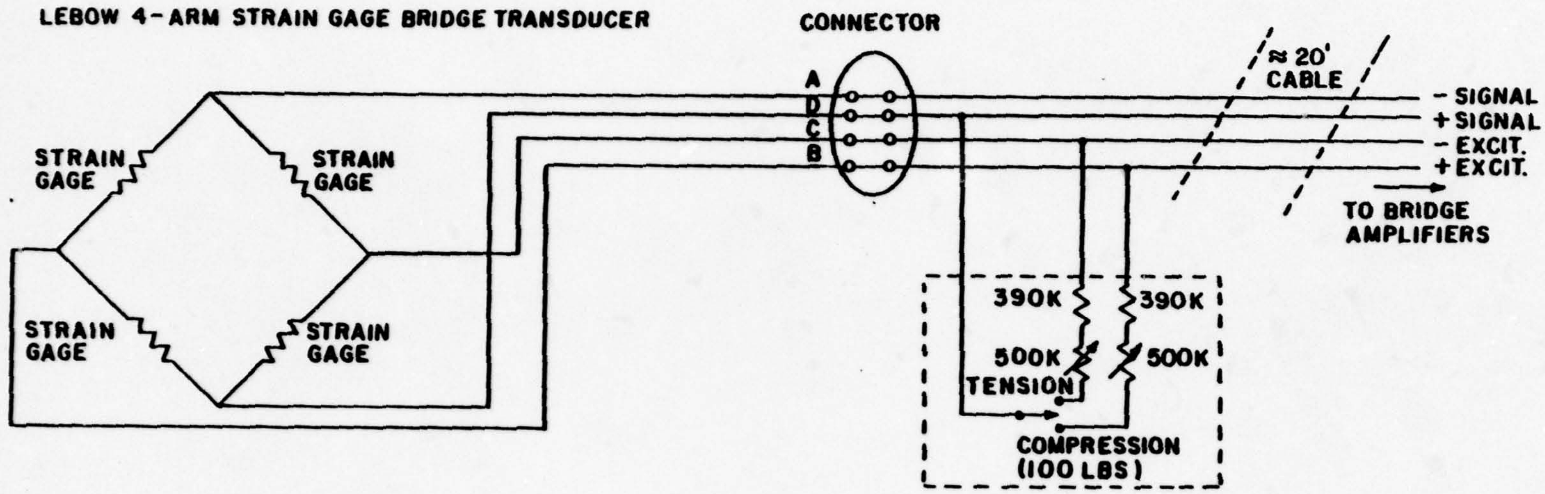


Figure 21. Diagram Representing a Single Channel of a 3-Channel HERCULES Bridge Transducer System.

3.1.2.5 Remote Strip Chart ON/OFF Switch

A toggle switch was installed on the remote control unit to provide for remotely activating the strip chart paper drive mechanism.

3.2 PROCEDURES

Data collection procedures required modifications for two reasons: the equipment modifications, and analog data processing constraints. Because of constraints of equipment capabilities of the ASD Computer Center Hybrid Simulation Division, data collection procedures were modified to facilitate the conversion of analog data.

Through the process of identifying sources of errors in the data analysis system, several procedural improvements to the analog-to-digital conversion process were recommended. Additionally, a computer program was prepared to provide a means of organizing the data collection procedure and to provide an automated check of the digital data.

3.2.1 <u>Computer-Generated Data Collection Format</u>

A program named RANDM has been developed for the HERCULES experiment to print an experimental data collection sequence which contains information the experimenter needs to position the force handle, select a direction of exertion, and select a subject to perform that exertion. The programmer uses the IBM System Subroutine RANDU to generate the random numbers which, in turn, are used to generate the sequence of steps to be followed in the procedure. A detailed description of the subroutine RANDU can be found in the IBM Scientific Subroutine Manual (Reference 7). All random numbers generated by RANDU are 15 digit decimal numbers between 0. and 1.

3.2.1.1 Method

In order to assure a unique set of random numbers throughout each execution of the program RANDM a new 15 digit seed number is supplied to the random number generator the first time it is called by

RANDM. A random handle position number is found by multiplying the first random number obtained from RANDU by a number which is one greater than the number of positions possible, and truncating the result to an integer value. All exertion directions are then randomized for each subject within each position using the same randomization process. If the number of simultaneous subjects is n, subject i will start as the first subject of the first position, and subject i+1 will start as the first subject of the next position. This sequence is continued until the n^{th} subject is reached. At this point the same sequence is repeated until all handle positions have been used. The last exertion is a sequence for a given handle position is a repetition of the first exertion direction/subject combination. For this repeated exertion, a constant (100) is added to the subject number to set it apart from the other subject numbers. This repetition is performed to provide a verification of the subject's performance reliability (see Figure 22). At the end of the program, the seed number to be used when the program is run again is printed out. This is done to make sure all numbers are randomized properly (see Figure 23). A flowchart of program RANDM is shown in Figure 24.

3.2.1.2 Program Input Data

The first data card read by the program RANDM gives information on the number of exertion directions (nexr), handle positions (npos) and simultaneous subjects (nsub) which are to follow. Any number up to 9 exertion directions, 99 handle positions, and 5 simultaneous subjects are possible. These numbers are right justified (see Figure 25a).

The following group of nexr cards will be the exertion directions. Each card contains one exertion direction number (iexr) and its 8 character name (exertion-direction name). The exertion direction number is an integer and is right justified in the field (see Figure 25b).

The second group of npos cards read will each have one handle position number (ipos) and the three dimensional coordinates of that handle position (lat dim, fwd dim, vert dim), as shown in Figure 25c.

POSITION 4 LATERAL= -20 FORWARD= 30 VERTICAL= 30

	SUBJECT NO.	NAME	EXERTION	DIRECTION
1	7301	PAT	404	DOWN
2	7302	TOM	204	RIGHT
3	7301	PAT	504	FOREWARD
4	7302	TOM	304	UP
5	7301	PAT	104	LEFT
6	7302	TOM	504	FOREWARD
7	7301	PAT	304	UP
8	7302	TOM	604	BACKWARD
9	7301	PAT	204	RIGHT
10	7302	TOM	104	LEFT
11	7301	PAT	604	BACKWARD
12	7302	TOM	404	DOWN
13	7401	PAT	404	DOWN

Figure 22. Sample Data Collection Sequence, with Subject 1 Repeated.

POSITION 7 LATERAL= -20 FORWARD= 30 VERTICAL= 20

	SUBJECT NO.	NAME	EXERTION	DIRECTION
144	7302	TOM	507	FOREWARD
145	7301	PAT	607	BACKWARD
146	7302	TOM	207	RIGHT
147	7301	PAT	507	FOREWARD
148	7302	TOM	607	BACKWARD
149	7301	PAT	207	RIGHT
150	7302	TOM	307	UP
151	7301	PAT	107	LEFT
152	7302	TOM	107	LEFT
153	7301	PAT	407	CCWN
154	7302	TOM	407	CCWN
155	7301	PAT	307	UP
156	7402	TOM	507	FOREWARD

NEW SEED TO BE USED = 727020575.

Figure 23. Sample Data Collection Sequence, with New Seed Number Printed.

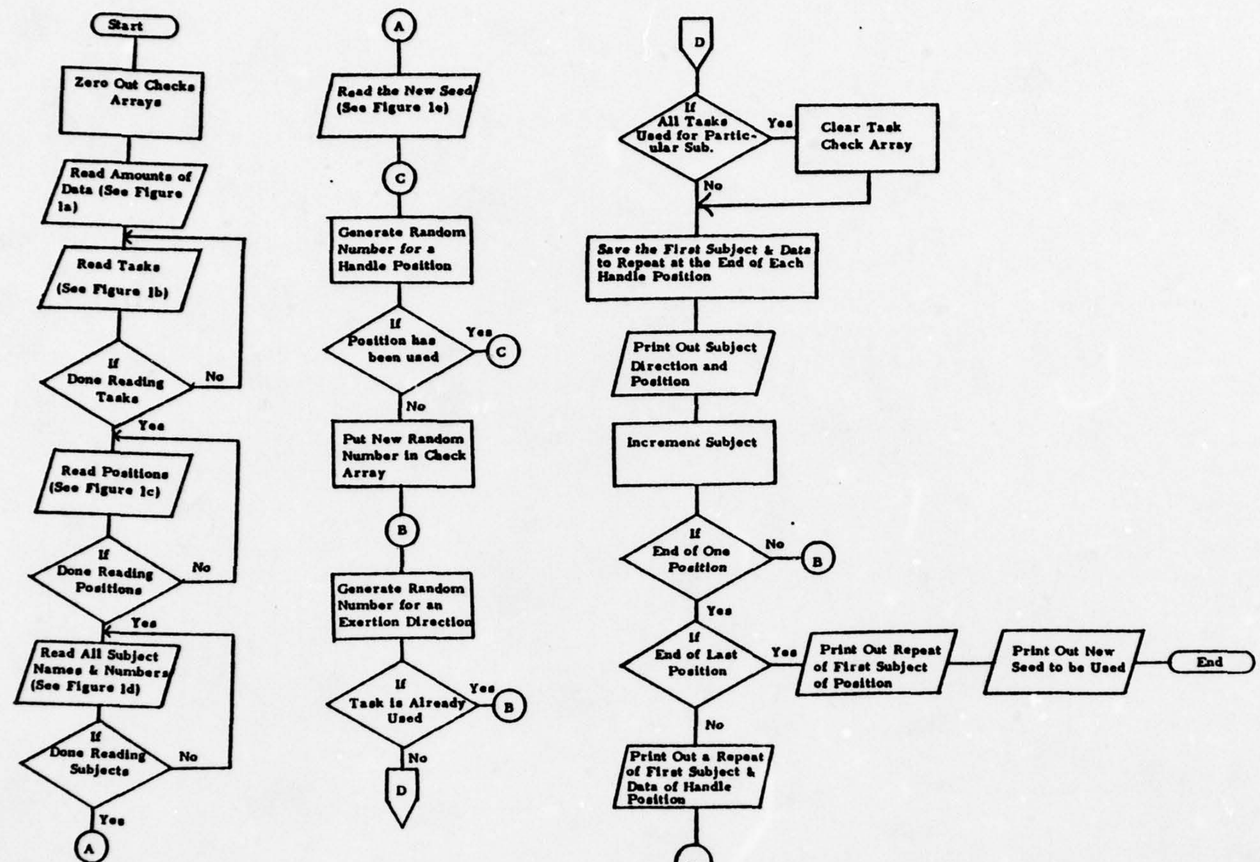


Figure 24. Flow Diagram for Program RANDM.

IBM

INTERNATIONAL BUSINESS MACHINES CORPORATION

MULTIPLE-CARD AYOUT FORM

Company ____________ Application ____________ by ____________ Date ________ Job No. ________ Sheet No. ______

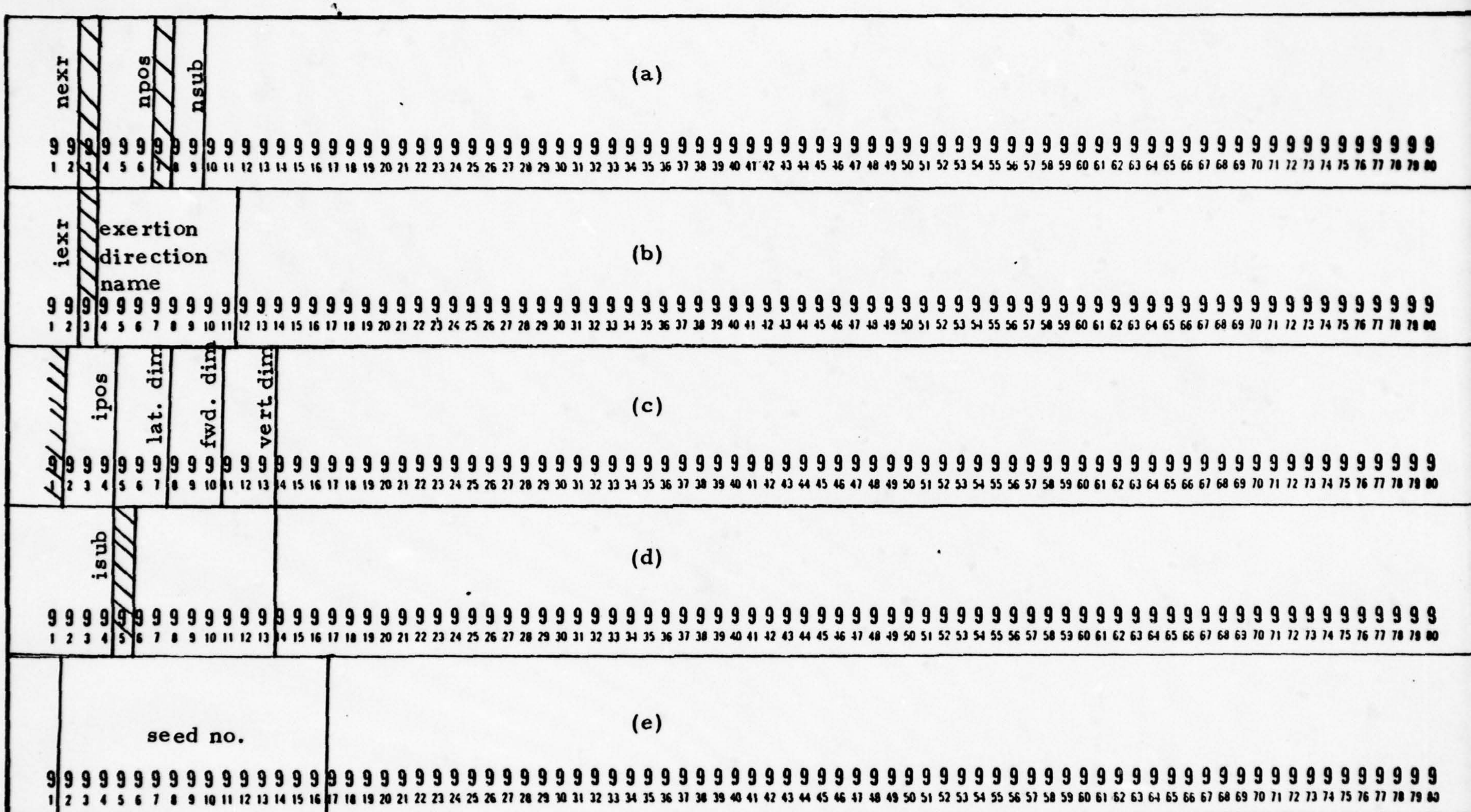


Figure 25. Input Data Formats for Program RANDM.

The third group of nsub cards read will each contain one subject number (isub) and the subject's first name (subject name). The subject number is an integer value and should be right justified (see Figure 25 d).

The last card read should be the initial seed number for the program. The seed is right justified and must have a decimal point at the right-most position (see Figure 25e).

3.2.1.3 Program Output

The first output format generated is a repeat of the input data. This provides a means of verifying the input data (see Figure 26).

The second output format contains random position number, its three-dimensional coordinates, and its associated experimental data collection sequence. This consists of all exertion directions, randomized for each subject. This format will be used for all handle positions. No handle positions are repeated, and for each position no exertion directions are repeated for any one subject.

In addition to printing the output on paper this program will also punch the output data on cards for use in verifying the experimentally gathered digital data.

```
INPUT
-----
 6   12   2
  1 LEFT
  2 RIGHT
  3 UP
  4 DOWN
  5 FOREWARD
  6 BACKWARD
   1-20  20  40
   2-20  10  40
   3-20   0  40
   4-20  30  30
   5-20  20  30
   6-20  10  30
   7-20  30  20
   8-20  20  20
   9-20  10  20
  10-20  30  10
  11-20  20  10
  12-20  10  10
7301  PAT
7302  TCM
            1397643.
```

Figure 26. Repeat of Input to Program RANDM.

SECTION 4

MULTIPLE BIVARIATE PLOTTING PROGRAM (BIVPLOT)

A considerable effort was made during this contract period to develop a plotting program (BIVPLOT) to plot the frequencies of two anthropometric variables which the user has selected from two surveys. The frequency data from the two surveys are plotted within the same table. Built into BIVPLOT is the capability of producing single survey tables as well. Both of these can be used with data in either English or metric units. Only the general layout and statistical computations could be used from the existing AMRL bivariate program which was made to produce single surveys on a computer line printer. An example of the output of this program is shown in Figure 27. While attempting to adapt this program for multi-survey plots on the printer it was found that the maximum number of print-characters contained in one print-line was not large enough to accommodate the number required by the multi-survey plots. Because of this, it was necessary to write the program for a computer plotter, rather than printer. The change from single to multiple survey tables necessitated a new input routine be established to handle the data from two surveys simultaneously.

4.1 THE PLOT

Subroutine TABLE was then written to produce a suitable table outline in which to plot the frequencies for the surveys' selected variables. Written for a general case, it produces only as many rows and columns for frequencies as are needed for each individual table. Control is returned to program BIVPLOT where the frequencies are then plotted and summary statistics for each survey can be calculated and plotted with each table. An example of this output is shown in Figure 28.

BIVARIATE TABLE FOR

WEIGHT HEIGHT

WEIGHT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	TTL
267.50																															
257.50																								1							1
247.50																															
237.50																															
227.50																		1		1											2
217.50																						1			1						2
207.50																				1		1			2						4
197.50																						2					1				3
187.50																		1							1			1			3
177.50						1													2	2		1	2	1							9
167.50															1			1	2	1											5
157.50													1	1	3			1	1			1	1	1							10
147.50										1			2	2	1	2		1	1	1		1							1		13
137.50										2			4	1	5	2		1					1								16
127.50	1					1		1	1		2		2	4	2	3		1													18
117.50						2		3	3	4	6		3	2	1																24
107.50	1				2	4			5	4	2		3	2																	23
97.50					2	2		2	3	1	1		1																		12
TOTAL	2				4	10		6	12	12	11		16	12	13	7		7	6	6		7	4	3	4		1	1	1		145

MIDVALUES FOR COLUMNS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1397.5	1417.5	1437.5	1457.5	1477.5	1497.5	1517.5	1537.5	1557.5	1577.5	1597.5	1617.5	1637.5	1657.5	1677.5

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1697.5	1717.5	1737.5	1757.5	1777.5	1797.5	1817.5	1837.5	1857.5	1877.5	1897.5	1917.5	1937.5	1957.5	1977.5

ASSORTED STATISTICS	MEAN	ST DEV	R	REGRESSION EQUATIONS & STD ERROR		
HEIGHT	1677.25	114.46	.778	= (2.747)* WEIGHT	1297.736	71.93
WEIGHT	138.16	32.42	.778	= (.220)* HEIGHT	-231.347	71.93

Figure 27. Line Printer Output for a Single Survey from Program BARE BIVAR.

A BIVARIATE FREQUENCY TABLE FOR
SITTING HEIGHT AND STATURE
USAF MEN/USAF WOMEN

STATURE (CM)

SITTING HEIGHT(CM)

	145.2	147.2	149.2	151.2	153.2	155.2	157.2	159.2	161.2	163.2	165.2	167.2	169.2	171.2	173.2	175.2	177.2	179.2	181.2	183.2	185.2	187.2	189.2	191.2	193.2	195.2	197.2	TOTAL
104.7																										1/		1/
103.7																						1/			1/			2/
102.7																								2/	1/			3/
101.7																						1/	2/	1/	1/			5/
100.7																						7/	2/	4/	2/	1/		16/
99.7																	1/	1/	3/	6/	8/	5/	7/	8/	3/		1/	42/
98.7																		6/	3/	4/	14/	13/	7/	1/	1/		1/	50/
97.7																1/	1/	13/	13/	12/	12/	22/	4/	2/	2/			82/
96.7															1/	5/	10/	10/ 1	23/	20/	19/	22/	4/	1/				123/ 1
95.7														5/	1/	12/	22/	34/	41/	26/	19/	8/	5/	1/	1/			171/
94.7											1/			2/	12/ 2	26/ 1	30/ 2	44/	44/	26/ 1	18/	10/	3/	2/				220/ 6
93.7													1/	6/ 1	27/	43/ 2	62/ 3	63/ 2	36/ 2	17/	11/	6/		1/				253/ 10
92.7										/ 2		1/ 2	6/ 4	31/ 5	42/ 4	33/ 1	44/ 4	33/ 3	13/	16/	6/	1/						225/ 25
91.7										1/	2/	6/ 6	10/10	33/ 8	46/13	51/ 2	49/ 2	27/ 1	14/	4/	3/							245/ 43
90.7									/ 1	1/ 4	4/ 7	10/10	20/12	46/12	37/ 7	26/ 1	24/ 2	12/	3/	3/		1/						190/ 56
89.7									/ 5	1/14	6/14	15/20	15/32	37/10	27/14	13/ 2	17/ 1	5/ 1	6/									142/121
88.7							1/ 1	/ 2	/12	4/23	8/23	22/34	17/22	17/21	15/ 6	7/ 4	8/	/ 1	1/									100/149
87.7						/ 1	/ 6	1/12	1/30	4/34	10/37	12/40	13/10	14/12	8/ 7	7/	3/											73/205
86.7						/ 3	/11	1/22	3/44	4/43	1/36	5/34	3/16	3/ 6	4/ 2	1/		1/	1/									27/217
85.7				/ 1	/ 1	/ 9	/16	/31	2/43	3/50	2/40	2/20	1/10	/ 1	1/ 2													11/231
84.7				/ 3	/10	/21	/37	2/50	1/40	3/44	1/20	1/15	/ 3	/ 1	/ 1													8/259
83.7		/ 1		/ 4	/14	/19	/47	/42	/41	1/19	1/ 8	1/ 2	/ 3															3/200
82.7		/ 1		/ 4	/18	/38	/39	/27	/29	/ 8	/ 4	/ 4		/ 1														/172
81.7		/ 1		/15	/20	/40	/28	/13	/12	/ 6	/ 1	/ 1																/143
80.7			/ 4	/13	/12	/10	/12	1/10	/ 8	/ 1																		1/ 74
79.7	/ 2	/ 2	/ 7	/ 9	/10	/10	/ 4		/ 1	/ 2																		/ 47
78.7		/ 3	/ 6	/ 7	/ 8	/ 2		/ 1																				/ 24
77.7			/ 2	/ 3	/ 5	/ 2	/ 1																					/ 13
76.7		/ 1																										/ 1
75.7				/ 2	/ 1																							/ 3
TOTAL	/ 2	/ 9	/ 18	/ 67	/ 96	/ 162	1/ 201	6/ 210	7/ 272	22/ 246	36/ 190	76/ 196	91/ 130	190/ 87	221/ 60	224/ 13	269/ 14	247/ 9	201/ 2	131/ 1	110/	87/	34/	23/	12/	2/	2/	2000/ 2000

USAF MEN ASSORTED STATISTICS	MEAN	ST DEV	R	REGRESSION EQUATIONS	STD ERROR
STATURE(CM)	177.34	6.19	0.788	= (1.535)*SITTING HEIGHT(CM)+(34.31)	3.81
SITTING HEIGHT(CM)	93.18	3.18	0.788	= (0.404)*STATURE(CM)+(21.54)	1.96

USAF WOMEN ASSORTED STATISTICS	MEAN	ST DEV	R	REGRESSION EQUATIONS	STD ERROR
STATURE(CM)	162.10	6.00	0.801	= (1.517)*SITTING HEIGHT(CM)+(32.25)	3.60
SITTING HEIGHT(CM)	85.60	3.17	0.801	= (0.423)*STATURE(CM)+(17.03)	1.90

DATE: 11/16/76
METRIC
PLOT: 48

Figure 28. Metric BIVPLOT Output.

4.2 TABLE OF CONTENTS

Each bivariate table is also dated, numbered, and labeled as containing either METRIC or ENGLISH data. The numbering is done to keep track of the large volume of plots which are anticipated. Program CONTENTS was written to keep track of these plots. It uses the variable number of the sets of user-selected anthropometric variables with their respective plot numbers to produce a cross-reference table of contents for the plots. A sample cross-reference table is shown in Figure 29.

4.3 BIVPLOT MULTIPLE SURVEY TAPES

Data surveys used in generating bivariate tables are stored primarily on individual magentic tapes. Handling two complete data survey tapes simultaneously, to generate a set of plots takes a considerable amount of computer time. The two surveys of interest have been the 1967 USAF MEN and the 1968 USAF WOMEN surveys. The primary interest in these surveys has been to see the relationship between sizes of men and women, to assist in the process of sizing uniforms and equipment to fit both males and females. To reduce input time for the plots using these surveys, 72 variables, which were common to both surveys were selected from the 204 variables in the men's survey and the 156 variables in the women's survey. These 72 selected variables were judged to be most useful for the sizing procedures. The common variables from the two survey tapes were combined into one tape containing all the pertinent information needed to run any combination of these variables over both surveys. In combining the tapes, all data were converted to metric units (cm/kg/years). The pertinent information for each variable included new range data based on the overall minimum and maximum values over both surveys, a plot step size factor, and a conversion factor for converting the metric unit to an English unit. Figure 30 shows the comparable variables from both surveys, and gives the range of values for each variable in the original unit of measurement. Figure 31 shows the data contained on the combined tape.

BIVARIATES FOR USAF MEN VS. WOMEN
(METRIC/ENGLISH PLOT NO.)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
1 AGE		1	2										3												4	5										
2 HEIGHT	1		7										8									9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
3 STATURE	2	7		39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56				160						57					
4 CERVICALE HEIGHT			39		62	63	64	65	66	67	68	69	70																							
5 ACROMION HEIGHT			40	62		71	72	73	74	75	76	77	78																							
6 SUPRASTERNALE HEIGHT			41	63	71		79	80	81	82	83	84	85																							
7 TROCHANTERION HEIGHT			42	64	72	79		86	87	88	89	90	91								148															
8 BUTTOCK HEIGHT			43	65	73	80	86		92	93																										
9 GLUTEAL FURROW HEIGHT			44	66	74	81	87	92		94																										
10 CROTCH HEIGHT			45	67	75	82	88	93	94																95											
11 ANKLE HEIGHT			46	68	76	83	89					96																								
12 LATERAL MALLEOLUS HEIGHT			47	69	77	84	90				96																									
13 SITTING HEIGHT	3	8	48	70	78	85	91							97	98	99	100	101	102	103	104															
14 EYE HEIGHT.SITTING			49										97		106	107	108	109	110	111	112															
15 MIDSHOULDER HEIGHT.SIT			50										98	106		114	115	116	117	118	119															
16 ELBOW REST HEIGHT.SIT			51										99	107	114		121	122	123	124	125															
17 POPLITEAL HEIGHT.SITTING			52										100	108	115	121		127	128	129	130															
18 BUTTOCK-POPLITEAL LENGTH			53										101	109	116	122	127		132	133	134															
19 BUTTOCK-KNEE LENGTH			54										102	110	117	123	128	132		136	137															
20 ACROMION-RADIALE LENGTH			55										103	111	118	124	129	133	136		139															
21 RADIALE-STYLION LENGTH			56				148						104	112	119	125	130	134	137	139																
22 SHOULDER CIRCUMFERENCE		9																																		
23 CHEST CIRC AT SCYE		10																																		
24 CHEST CIRCUMFERENCE		11																							144						146					
25 WAIST CIRC-OMPHALION	4	12	160							95														144												
26 BUTTOCK CIRCUMFERENCE	5	13																																		
27 UPPER THIGH CIRC		14																																		
28 KNEE CIRCUMFERENCE		15																																		
29 CALF CIRCUMFERENCE.RIGHT		16																																		
30 ANKLE CIRCUMFERENCE		17																																		
31 VERTICAL TRUNK CIRC		18	57																					146												
32 VERTICAL TRUNK CIRC.SIT		19																																		
33 BUTTOCK CIRC.SIT		20																																		
34 SCYE CIRCUMFERENCE		21																																		
35 BICEPS CIRC.EXTENDED/RT		22																																		
36 BICEPS CIRC.FLEXED/RIGHT		23																																		

Figure 29. Table of Contents for 1967 USAF Men Vs. 1968 USAF Women Plots; Plotted by Program Contents.

Page 1 of 4

BIVARIATES FOR USAF MEN VS. WOMEN
(METRIC/ENGLISH PLOT NO.)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
37 ELBOW CIRC. FLEXED		24																																		
38 LOWER ARM CIRC. FLEXED		25																																		
39 WRIST CIRCUMFERENCE		26																																		
40 BIACROMIAL BREADTH		27	38																	140	143															
41 BIDELTOID BREADTH		28	39																																	
42 CHEST BREADTH		29	40																																	
43 HIP BREADTH		30	41																																	
44 BUTTOCK DEPTH		31																																		
45 THIGH CLEARANCE HEIGHT		32											108	113	120	126	131	135	138	141																
46 SHOULDER LENGTH		33																																		
47 INTERSCYE		34																																		
48 INTERSCYE MAXIMUM		35																																		
49 WAIST BACK-OMPHALION		36																																		
50 SLEEVE INSEAM		37																																		
51 SLEEVE LGT/SPINE-WRIST		38																																		
52 HAND LENGTH																																				
53 HAND BREADTH																																				
54 HAND CIRCUMFERENCE																																				
55 FOOT LENGTH																																				
56 FOOT BREADTH																																				
57 HEAD LENGTH																																				
58 HEAD BREADTH																																				
59 HEAD CIRCUMFERENCE																																				
60 BITRAGION-CORONAL ARC																																				
61 BIOCULAR BREADTH																																				
62 BITRAGION BREADTH																																				
63 BIZIGOMATIC BREADTH																																				
64 BIGONIAL BREADTH																																				
65 NOSE BREADTH																																				
66 LIP LENGTH																																				
67 MENTON-SUBNASALE LENGTH																																				
68 MENTON-SELLION LENGTH																																				
69 SUBNASALE-SELLION LENGTH																																				
70 EAR LENGTH																																				
71 EAR BREADTH																																				
72 GRIP STRENGTH																																				

Figure 29 (Continued)

Page 2 of 4

BIVARIATES FOR USAF MEN VS. WOMEN
(METRIC/ENGLISH PLOT NO.)

	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
1 AGE																																				6
2 HEIGHT	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38																					
3 STATURE				58	59	60	61																													
4 CERVICALE HEIGHT																																				
5 ACROMION HEIGHT																																				
6 SUPRASTERNALE HEIGHT																																				
7 TROCHANTERION HEIGHT																																				
8 BUTTOCK HEIGHT																																				
9 GLUTEAL FURROW HEIGHT																																				
10 CROTCH HEIGHT																																				
11 ANKLE HEIGHT																																				
12 LATERAL MALLEOLUS HEIGHT																																				
13 SITTING HEIGHT									108																											
14 EYE HEIGHT.SITTING									113																											
15 MIDSHOULDER HEIGHT.SIT									120																											
16 ELBOW REST HEIGHT.SIT									126																											
17 POPLITEAL HEIGHT.SITTING									131																											
18 BUTTOCK-POPLITEAL LENGTH									136																											
19 BUTTOCK-KNEE LENGTH									138																											
20 ACROMION-RADIALE LENGTH				140					141																											
21 RADIALE-STYLION LENGTH				143																																
22 SHOULDER CIRCUMFERENCE																																				
23 CHEST CIRC AT SCYE																																				
24 CHEST CIRCUMFERENCE																																				
25 WAIST CIRC-OMPHALION																																				
26 BUTTOCK CIRCUMFERENCE																																				
27 UPPER THIGH CIRC																																				
28 KNEE CIRCUMFERENCE																																				
29 CALF CIRCUMFERENCE.RIGHT																																				
30 ANKLE CIRCUMFERENCE																																				
31 VERTICAL TRUNK CIRC																																				
32 VERTICAL TRUNK CIRC.SIT																																				
33 BUTTOCK CIRC.SIT																																				
34 SCYE CIRCUMFERENCE																																				
35 BICEPS CIRC.EXTENDED/RT																																				
36 BICEPS CIRC.FLEXED/RIGHT																																				

Figure 29 (Continued)

Page 3 of 4

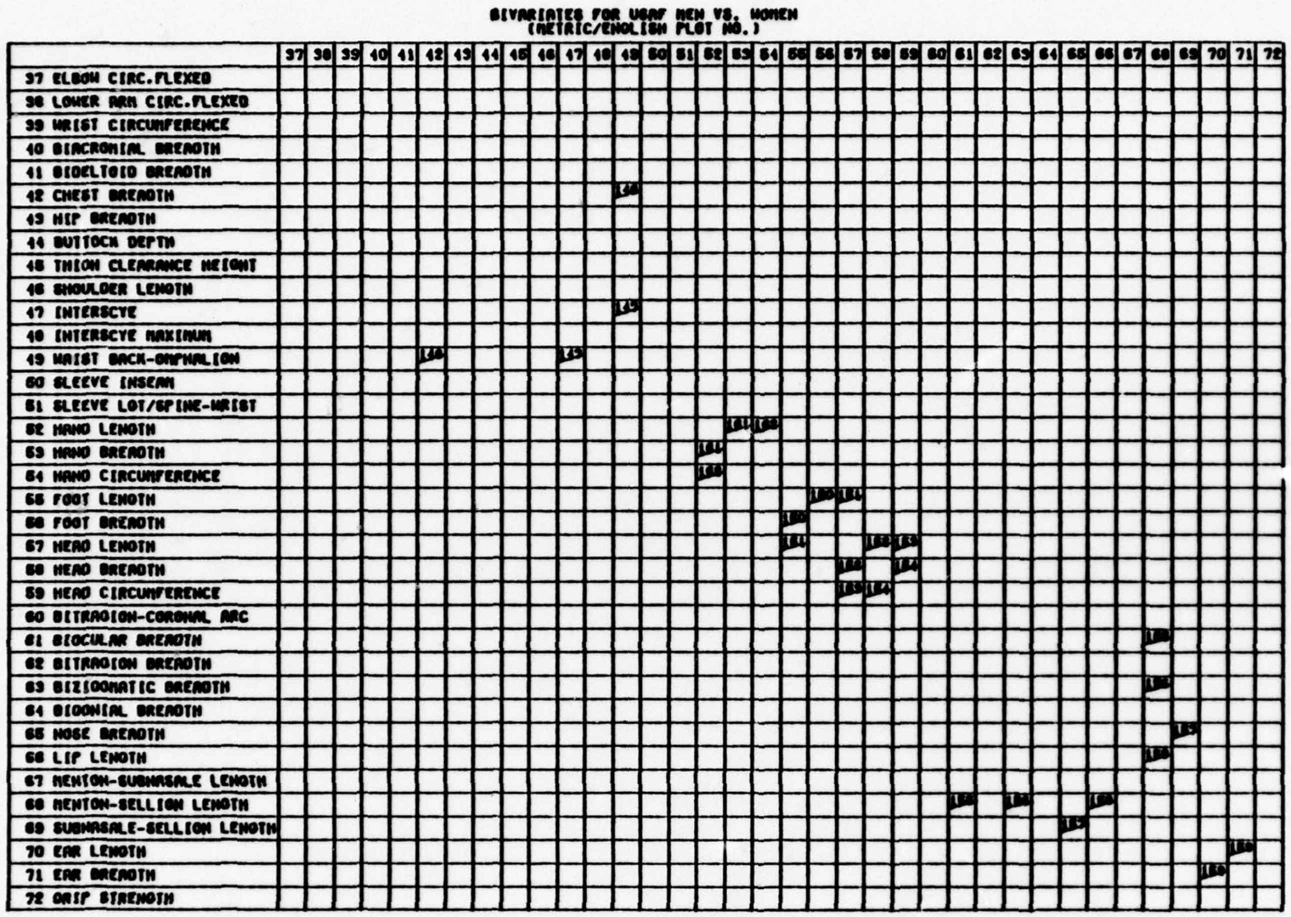


Figure 29 (Continued)

Page 4 of 4

NO.	1967 USAF MEN SURVEY NO.	VARIABLE NAME	MINIMUM	MAXIMUM	1968 USAF WOMEN SURVEY NO.	VARIABLE NAME	MINIMUM	MAXIMUM
1	1	AGE	2100.00	5650.00	1	AGE	177.50	565.00
2	2	WEIGHT	117.50	264.00	2	WEIGHT	82.50	200.00
3	13	HEIGHT (STATURE)	1577.50	1972.00	7	STATURE	1442.50	1830.00
4	14	CERVICALE HEIGHT	1342.50	1702.00	9	CERVICALE HEIGHT	1202.50	1568.00
5	15	ACROMION HEIGHT	1277.50	1644.00	10	ACROMIAL HEIGHT	1142.50	1520.00
6	19	SUPRASTERNALE HGHT	1267.50	1623.00	11	SUPRASTERNALE HGHT	1162.50	1506.00
7	24	TROCHANTERION HGHT	787.50	1119.00	15	TROCHANTERIC HGHT	682.50	965.00
8	23	BUTTOCK HEIGHT	767.50	1098.00	16	BUTTOCK HEIGHT	642.50	966.00
9	25	GLUTEAL FURROW HGT	682.50	986.00	17	GLUTEAL FURROW HGT	582.50	864.00
10	26	CROTCH HEIGHT	712.50	1035.00	19	CROTCH HEIGHT	602.50	875.00
11	31	ANKLE HEIGHT	103.50	183.00	20	ANKLE HEIGHT	72.50	160.00
12	132	LAT L MALLEOLUS HT	53.50	89.00	21	LAT L MALLEOLUS HT	47.50	87.00
13	32	SITTING HEIGHT	807.50	1048.00	23	SITTING HEIGHT	752.50	964.00
14	33	EYE HEIGHT/SITTING	682.50	910.00	24	EYE HEIGHT,SITTING	632.50	831.00
15	34	MIDSHOULDER HT/SIT	537.50	746.00	25	MIDSHOULDER HT,SIT	502.50	672.00
16	36	ELBOW REST HGT/SIT	152.50	351.00	27	ELBOW REST HEIGHT	142.50	295.00
17	38	POPLITEAL HGHT/SIT	362.50	512.00	28	POPLITEAL HEIGHT	332.50	471.00
18	40	BUTTOCK-POPLITEAL	422.50	598.00	29	BUTTOCK-POPLIT L L	382.50	585.00
19	39	BUTTOCK-KNEE LNGTH	517.50	696.00	30	BUTTOCK-KNEE LNGTH	482.50	664.00
20	43	ACROMION-RADIALE L	271.50	393.00	31	ACROMION-RADIALE L	252.50	365.00
21	45	RADIALE-STYLION LH	224.50	314.00	32	RADIALE-STYLION L	187.50	280.00
22	67	SHOULDER CIRCUM CE	997.50	1367.00	37	SHOULDER CIRCUMFER	862.50	1221.00
23	68	CHEST CIRC AT SCYE	792.50	1243.00	38	CHEST CIRC AT SCYE	702.50	1035.00
24	69	CHEST CIRCUMF ENCE	772.50	1214.00	39	BUST CIRCUMFERENCE	742.50	1139.00
25	70	WAIST CIR-OMPHAL N	677.50	1246.00	41	WAIST CIRCUMFERNCE	522.50	951.00
26	72	BUTTOCK CIRCUMF CE	812.50	1244.00	44	HIP C-9 BLW WAIST	762.50	1201.00
27	96	UPPER THIGH CIRCUM	452.50	759.00	45	UPPER THIGH CIRCUM	422.50	720.00
28	98	KNEE CIRCUMFERENCE	312.50	482.00	46	KNEE CIRCUMFERENCE	302.50	457.00
29	100	CALF CIRCUMF/RIGHT	297.50	452.00	47	CALF CIRCUM, RIGHT	262.50	445.00
30	102	ANKLE CIRCUMF ENCE	181.50	267.00	49	ANKLE CIRCUMFERNCE	172.50	256.00
31	74	VERTICAL TRUNK CIR	1422.50	1975.00	50	VERTICAL TRUNK CIR	1342.50	1782.00
32	75	VERT TRUNK CIR/SIT	1367.50	1856.00	51	VERTICAL TRK C,SIT	1322.50	1705.00
33	73	BUTTOCK CIRCUM/SIT	867.50	1411.00	52	BUTTOCK CIRC, SIT	842.50	1284.00
34	103	SCYE CIRCUMFERENCE	402.50	594.00	53	SCYE CIRCUMFERENCE	282.50	490.00
35	104	BICEPS C-EXTEND/RT	227.50	388.00	55	BICEPS C,RELAXED,R	192.50	374.00
36	106	BICEPS C-FLEXED/RT	252.50	408.00	56	BICEPS C,FLEXED, R	192.50	390.00
37	109	ELBOW CIRC-FLEXED	258.50	369.00	59	ELBOW CIRC, FLEXED	212.50	358.00
38	111	LOWER ARM C-FLEXED	241.50	354.00	61	FOREARM C, FLEXED	192.50	328.00
39	112	WRIST CIRCUMF ENCE	150.50	268.00	62	WRIST CIRCUMFERNCE	122.50	176.00
40	50	BIACROMIAL BREADTH	337.50	474.00	63	BIACROMIAL BREADTH	307.50	416.00
41	51	BIDELTOID BREADTH	397.50	567.00	64	BIDELTOID BREADTH	342.50	501.00
42	52	CHEST BREADTH	257.50	415.00	65	CHEST BREADTH	222.50	359.00
43	55	HIP BREADTH	282.50	446.00	68	HIP BREADTH	282.50	441.00
44	64	BUTTOCK DEPTH	170.50	338.00	77	BUTTOCK DEPTH	152.50	306.00
45	65	THIGH CLEARANCE HT	124.50	217.00	78	THIGH CLEARANCE	87.50	169.00
46	118	SHOULDER LENGTH	131.50	217.00	79	SHOULDER LENGTH	112.50	188.00
47	120	INTERSCYE	270.50	514.00	82	INTERSCYE	272.50	442.00
48	121	INTERSCYE MAXIMUM	492.50	713.00	83	INTERSCYE, MAXIMUM	372.50	605.00
49	124	WAIST BACK-OMPHL N	402.50	563.00	85	WAIST BACK	332.50	481.00
50	49	SLEEVE INSEAM	397.50	578.00	87	SLEEVE INSEAM	362.50	535.00
51	115	SLVE L/SPINE-WRIST	787.50	1045.00	90	SPINE-TO-WRIST LTH	672.50	912.00
52	134	HAND LENGTH	166.50	222.00	91	HAND LENGTH	152.50	220.00
53	136	HAND BR/METACARPLE	75.50	102.00	92	HAND BREADTH	60.50	88.00
54	138	HAND C/METACARPALE	183.50	247.00	93	HAND CIRCUMFERENCE	147.50	215.00
55	125	FOOT LENGTH	231.50	313.00	94	FOOT LENGTH	207.50	276.00
56	127	FOOT BREADTH	83.50	117.00	95	FOOT BREADTH	67.50	110.00
57	150	HEAD LENGTH	174.50	226.00	96	HEAD LENGTH	162.50	207.00
58	156	HEAD BREADTH	138.50	176.00	97	HEAD BREADTH	122.50	171.00
59	141	HEAD CIRCUMFERENCE	526.50	620.00	98	HEAD CIRCUMFERENCE	497.50	617.00
60	144	BITRAGION-CORONAL	320.50	402.00	112	BITRAGION-CORONAL	287.50	392.00
61	162	BIOCULAR BREADTH	77.50	108.00	113	BIOCULAR BREADTH	78.50	112.00
62	158	BITRAGION BREADTH	123.50	161.00	115	BITRAGION BREADTH	112.50	152.00
63	159	BIZYGOMATIC BR DTH	123.50	159.00	116	BIZYGOMATIC BRDTH	108.50	149.00
64	160	BIGONIAL BREADTH	94.50	142.00	117	BIGONIAL BREADTH	80.50	122.00
65	165	NOSE BREADTH	26.50	51.00	118	NASAL BREADTH	22.50	46.00
66	166	LIP LENGTH	38.50	66.00	119	LIP LENGTH	30.50	58.00
67	171	MENTON-SUBNASALE L	52.50	89.00	120	MENTON-SUBNASALE L	38.50	75.00
68	172	MENTON-NASAL ROOT	97.50	143.00	121	MENTON-SELLION LTH	86.50	128.00
69	168	SUBNASALE-NASAL RT	38.50	64.00	122	SUBNASALE-SELLION	30.50	61.00
70	154	EAR LENGTH	48.50	83.00	123	EAR LENGTH	34.50	69.00
71	153	EAR BREADTH	26.50	51.00	124	EAR BREADTH	18.50	42.00
72	12	GRIP STRENGTH	32.50	86.00	125	GRIP STRENGTH	9.50	53.00

Figure 30. Survey Variable Names, Numbers and Ranges from the Individual Survey Tapes.

```
REC 0001.. ********** A COMBINED TAPE FOR USAF WOMEN(1968), AND USAF MEN(1967) **********
REC 0002..  72 VARIABLES  USAF MEN/USAF WOMEN                          19  2420 MEN  1905 WOMEN
REC 0003.. (I3,1X,6A4,I3,3F9.2,F11.7,3X,2A4)
REC 0004.. (I4,19F4.1,/,(20F4.1))
REC 0005..   1 AGE                         3    18.50    57.00     1.50  1.0000000   (YR)(YR)
REC 0006..   2 WEIGHT                      6    37.42   119.75     3.00  2.2046223   (KG)(LB)
REC 0007..   3 STATURE                     7   144.25   197.20     2.00  0.3937008   (CM)(IN)
REC 0008..   4 CERVICALE HEIGHT           16   120.25   170.20     2.00  0.3937008   (CM)(IN)
REC 0009..   5 ACROMION HEIGHT            15   114.25   164.40     2.00  0.3937008   (CM)(IN)
REC 0010..   6 SUPRASTERNALE HEIGHT       20   116.25   162.30     2.00  0.3937008   (CM)(IN)
REC 0011..   7 TROCHANTERION HEIGHT       20    68.25   111.90     1.50  0.3937008   (CM)(IN)
REC 0012..   8 BUTTOCK HEIGHT             14    64.25   109.80     2.00  0.3937008   (CM)(IN)
REC 0013..   9 GLUTEAL FURROW HEIGHT      21    58.25    98.60     1.50  0.3937008   (CM)(IN)
REC 0014..  10 CROTCH HEIGHT              13    60.25   103.50     1.50  0.3937008   (CM)(IN)
REC 0015..  11 ANKLE HEIGHT               12     7.25    18.30     0.40  0.3937008   (CM)(IN)
REC 0016..  12 LATERAL MALLEOLUS HEIGHT   24     4.75     8.90     0.20  0.3937008   (CM)(IN)
REC 0017..  13 SITTING HEIGHT             14    75.25   104.80     1.00  0.3937008   (CM)(IN)
REC 0018..  14 EYE HEIGHT,SITTING         18    63.25    91.00     1.00  0.3937008   (CM)(IN)
REC 0019..  15 MIDSHOULDER HEIGHT,SIT     22    50.25    74.60     1.00  0.3937008   (CM)(IN)
REC 0020..  16 ELBOW REST HEIGHT,SIT      21    14.25    35.10     0.80  0.3937008   (CM)(IN)
REC 0021..  17 POPLITEAL HEIGHT,SITTING   24    33.25    51.20     0.60  0.3937008   (CM)(IN)
REC 0022..  18 BUTTOCK-POPLITEAL LENGTH   24    38.25    59.80     0.80  0.3937008   (CM)(IN)
REC 0023..  19 BUTTOCK-KNEE LENGTH        19    48.25    69.60     0.80  0.3937008   (CM)(IN)
REC 0024..  20 ACROMION-RADIALE LENGTH    23    25.25    39.30     0.60  0.3937008   (CM)(IN)
REC 0025..  21 RADIALE-STYLION LENGTH     22    18.75    31.40     0.60  0.3937008   (CM)(IN)
REC 0026..  22 SHOULDER CIRCUMFERENCE     22    86.25   136.70     2.00  0.3937008   (CM)(IN)
REC 0027..  23 CHEST CIRC AT SCYE         18    70.25   124.30     2.00  0.3937008   (CM)(IN)
REC 0028..  24 CHEST CIRCUMFERENCE        19    74.25   121.40     2.00  0.3937008   (CM)(IN)
REC 0029..  25 WAIST CIRC-OMPHALION       20    52.25   124.60     2.50  0.3937008   (CM)(IN)
REC 0030..  26 BUTTOCK CIRCUMFERENCE      21    76.25   124.40     2.00  0.3937008   (CM)(IN)
REC 0031..  27 UPPER THIGH CIRC           16    42.25    75.90     1.50  0.3937008   (CM)(IN)
REC 0032..  28 KNEE CIRCUMFERENCE         18    30.25    48.20     0.60  0.3937008   (CM)(IN)
REC 0033..  29 CALF CIRCUMFERENCE,RIGHT   24    25.25    45.20     0.80  0.3937008   (CM)(IN)
REC 0034..  30 ANKLE CIRCUMFERENCE        19    17.25    26.70     0.40  0.3937008   (CM)(IN)
REC 0035..  31 VERTICAL TRUNK CIRC        19   134.25   197.50     2.50  0.3937008   (CM)(IN)
REC 0036..  32 VERTICAL TRUNK CIRC,SIT    23   132.25   185.60     2.00  0.3937008   (CM)(IN)
REC 0037..  33 BUTTOCK CIRC,SIT           16    84.25   141.10     2.00  0.3937008   (CM)(IN)
REC 0038..  34 SCYE CIRCUMFERENCE         18    28.25    59.40     1.50  0.3937008   (CM)(IN)
REC 0039..  35 BICEPS CIRC,EXTENDED/RT    23    19.25    38.80     0.80  0.3937008   (CM)(IN)
REC 0040..  36 BICEPS CIRC,FLEXED/RIGHT   24    19.25    40.80     0.80  0.3937008   (CM)(IN)
REC 0041..  37 ELBOW CIRC,FLEXED          17    21.25    36.90     0.60  0.3937008   (CM)(IN)
REC 0042..  38 LOWER ARM CIRC,FLEXED      21    19.25    35.40     0.60  0.3937008   (CM)(IN)
REC 0043..  39 WRIST CIRCUMFERENCE        19    12.25    20.80     0.40  0.3937008   (CM)(IN)
REC 0044..  40 BIACROMIAL BREADTH         18    30.75    47.40     0.60  0.3937008   (CM)(IN)
REC 0045..  41 BIDELTOID BREADTH          17    34.25    56.70     0.80  0.3937008   (CM)(IN)
REC 0046..  42 CHEST BREADTH              13    22.25    41.50     0.80  0.3937008   (CM)(IN)
REC 0047..  43 HIP BREADTH                11    28.25    44.60     0.60  0.3937008   (CM)(IN)
REC 0048..  44 BUTTOCK DEPTH              13    15.25    33.80     0.80  0.3937008   (CM)(IN)
REC 0049..  45 THIGH CLEARANCE HEIGHT     22     8.75    21.70     0.60  0.3937008   (CM)(IN)
REC 0050..  46 SHOULDER LENGTH            15    11.25    21.70     0.40  0.3937008   (CM)(IN)
```

Figure 31. Combined Tape for Input to BIVPLOT.

Page 1 of 2

```
REC 0051.. 47 INTERSCYE                     9     27.05      51.40      1.00  0.3937008     (CM)(IN)
REC 0052.. 48 INTERSCYE MAXIMUM            17     37.25      71.30      1.50  0.3937008     (CM)(IN)
REC 0053.. 49 WAIST BACK-OMPHALION         20     33.25      56.30      0.80  0.3937008     (CM)(IN)
REC 0054.. 50 SLEEVE INSEAM                13     36.25      57.80      0.80  0.3937008     (CM)(IN)
REC 0055.. 51 SLEEVE LGT/SPINE-WRIST       22     67.25     104.50      1.50  0.3937008     (CM)(IN)
REC 0056.. 52 HAND LENGTH                  11     15.25      22.20      0.40  0.3937008     (CM)(IN)
REC 0057.. 53 HAND BREADTH                 12      6.05      10.20      0.20  0.3937008     (CM)(IN)
REC 0058.. 54 HAND CIRCUMFERENCE           18     14.75      24.70      0.40  0.3937008     (CM)(IN)
REC 0059.. 55 FOOT LENGTH                  11     20.75      31.30      0.40  0.3937008     (CM)(IN)
REC 0060.. 56 FOOT BREADTH                 12      6.75      11.70      0.20  0.3937008     (CM)(IN)
REC 0061.. 57 HEAD LENGTH                  11     16.25      22.60      0.40  0.3937008     (CM)(IN)
REC 0062.. 58 HEAD BREADTH                 12     12.25      17.60      0.20  0.3937008     (CM)(IN)
REC 0063.. 59 HEAD CIRCUMFERENCE           18     49.75      62.00      0.60  0.3937008     (CM)(IN)
REC 0064.. 60 BITRAGION-CORONAL ARC        21     28.75      40.20      0.40  0.3937008     (CM)(IN)
REC 0065.. 61 BIOCULAR BREADTH             16      7.75      11.20      0.20  0.3937008     (CM)(IN)
REC 0066.. 62 BITRAGION BREADTH            17     11.25      16.10      0.20  0.3937008     (CM)(IN)
REC 0067.. 63 BIZIGOMATIC BREADTH          19     10.85      15.90      0.20  0.3937008     (CM)(IN)
REC 0068.. 64 BIGONIAL BREADTH             16      8.05      14.20      0.40  0.3937008     (CM)(IN)
REC 0069.. 65 NOSE BREADTH                 12      2.25       5.10      0.20  0.3937008     (CM)(IN)
REC 0070.. 66 LIP LENGTH                   10      3.05       6.60      0.20  0.3937008     (CM)(IN)
REC 0071.. 67 MENTON-SUBNASALE LENGTH      23      3.85       8.90      0.20  0.3937008     (CM)(IN)
REC 0072.. 68 MENTON-SELLION LENGTH        21      8.65      14.30      0.20  0.3937008     (CM)(IN)
REC 0073.. 69 SUBNASALE-SELLION LENGTH     24      3.05       6.40      0.20  0.3937008     (CM)(IN)
REC 0074.. 70 EAR LENGTH                   10      3.45       8.30      0.20  0.3937008     (CM)(IN)
REC 0075.. 71 EAR BREADTH                  11      1.85       5.10      0.20  0.3937008     (CM)(IN)
REC 0076.. 72 GRIP STRENGTH                13      9.50      86.00      3.00  2.2046223     (KG)(LB)
REC 0077..  15 415 8121711147814351417 911 866 796 807 130  73 306 802 647 248 409 465 581
REC 0078.. 343 275116811221125 995 974 559 359 359 221168216271084 466 286 306 311 287 169
REC 0079.. 407 485 344 339 260 156 148 418 592 462 490 915 188  89 216 260  94 192 152 563
REC 0080.. 347  89 137 137 111  36  53  78 132  55  70  38 490
REC 0081..  16 415 771176615141427 1444 942 892 798 837 148  74 914 788 609 208 415 495 605
REC 0082.. 329 26811511026 975 941 957 578 384 373 223170115851042 487 326 332 308 289 180
REC 0083.. 404 477 336 343 222 165 165 426 622 456 488 899 193  92 221 249 101 202 156 580
REC 0084.. 341  91 143 141 121  39  54  74 136  57  65  36 520
REC 0085..  17 425 7801834156614861488 948 889 804 830 130  76 969 859 671 278 439 515 629
REC 0086.. 325 2611142 997 931 805 981 591 399 393 233175416961068 466 297 312 310 300 177
REC 0087.. 427 500 337 350 241 152 173 454 613 467 479 928 187  92 228 268 101 190 161 569
REC 0088.. 350  91 156 149 117  39  55  66 121  56  76  40 530
REC 0089..  18 445 8301779153614551464 946 926 833 839 136  72 932 802 640 239 442 501 616
REC 0090.. 335 282114110571034 9531043 618 380 367 215173016521155 442 326 349 332 294 185
REC 0091.. 408 487 349 382 258 153 160 422 576 461 499 902 186  92 214 272  97 195 148 557
REC 0092.. 325  91 145 138 106  33  49  66 121  52  68  40 510
REC 0093..  19 425 95318601603153615401018 996 892 911 158  72 939 824 668 275 474 531 647
REC 0094.. 346 29512451152111510201038 615 402 385 224174216701155 491 330 344 339 324 182
REC 0095.. 421 515 372 377 274 166 179 442 643 469 507 966 200  98 232 288 106 206 159 596
REC 0096.. 357  92 151 141 116  37  48  71 124  50  68  39 620
REC 0097..  20 395 95319561669160716051001 963 875 896 160  761048 900 714 289 474 530 630
REC 0098.. 350 279124511051066 8451016 582 409 392 244186417551077 492 344 357 342 322 204
REC 0099.. 451 520 369 369 240 156 178 488 655 512 504 937 210  98 229 297  96 221 160 618
REC 0100.. 394 100 152 155 117  41  59  80 143  64  79  43 640
```

Figure 31 (Continued)

In a like manner, the Health Examination Survey of men and women were put on another tape for their analyses.

4.4 EQUALIZING SAMPLE SIZES

In order to make these multiple bivariate plots (multi-bivplots) as useful as possible, the sample sizes were equalized. It was decided that only the first 2000 subjects from the 1967 USAF Male survey would be used, and datasets for 95 subjects would be added to the 1905 subjects on the 1968 USAF Female survey. These 95 datasets were chosen at random using a UDRI-written program, RANDOM, which, in turn, employed a random number generating routine from the CDC 6600 computer system. The original 2420-subject data values from the 1967 survey and the 1905-subject data values from the 1968 survey were used to caluclate the summary statistics.

4.5 SUMMARY

To date one English and 162 metric plots have been generated from the 1967 versus 1968 USAF surveys tape. Each plot is approximately 14"x10" in size and is plotted using a .2 mm India ink pen on the offline CALCOMP plotter at the ASD Computer Center (Building 676). Plot tapes are generated on the CDC 6600 computer system at Building 676 using the CDC 1700 remote job entry terminal at Building 441. These plot tapes are then read by the CALCOMP 780 magnetic tape unit and plotted with a CALCOMP 763 digital incremental zip-mode plotter. This route has offered the best resolution and quality of output. However, because of the time required to generate these plots on the CALCOMP plotter, only ten plots can be produced a day. Once the plots have been produced, they are reduced to 8½x11 inch size on a reducing copy machine in Building 676 for their general use.

The original and primary use for these plots by AMRL has been for the recent series of chemical warfare clothing and personal equipment sizing and fit tests. These multi-bivplots have been an aid in sizing face respirators, protective garments, and gloves for both men and women in the ground forces.

Further multi-bivplots are expected to be produced and used in the future. Program BIVPLOT, however, is not fully documented and further changes are to be made to BIVPLOT during the next contract period. A series of these bivariate plots will be published in 1977 along with a more extensive documentation of program BIVPLOT and its accompanying subroutines. At that time the input formats for BIVPLOT will also be documented in full.

SECTION 5
BIOSTEREOMETRIC DATA

This section contains the analysis of a new set of data obtained during this contract period. This set of data was collected for AMRL/HED by R. E. Herron et al., of the Biostereometrics Laboratory at the Texas Institute for Rehabilitation and Research, for the purpose of collecting mass distribution measurements for six anatomical specimens using biostereometrics (see Reference 8). This was done in conjunction with Chandler et al. (see Refer- 9) who used the pendelum method to gather mass distribution data on these same specimens.

5.1 HERRON'S BIOSTEREOMETRIC DATA

Herron's biostereometric cadaver data were obtained from AMRL during the contract period covered in this report, and some preliminary statistical analyses were performed on the data using program HER1. The substance of Herron's data was published in AMRL-TR-75-18 pages 56-193 (Reference 8).

Statistical analyses performed on these data have been the following:

A. New densities, called DENSITY 4, were calculated using Herron's volumes and measured cadaver weights, as reported in the Department of Transportation (DOT) report DOT HS-801 430, for each segment.

B. A mean DENSITY 4 was calculated for each segment.

C. Segment weights were recalculated using the DENSITY 4 mean value and Herron's volumes.

5.2 INPUT

Input for HER1 consisted of: a numbered variable name card for each segment, using a format of (I4, 1X, 3A4); a card for each segment with the DOT reported densities and weights for each of the six cadavers, using format

(I2, 2X, 6(F6.4, F6.1)); tables 9, 21, 33, 45, 57, and 69 from Herron's data, each followed by a blank card. Format information for Herron's data is shown in Figure 32.

5.3 SUMMARY

Figure 33 shows the general flow of program HER1, which was used to perform the original data analyses. Figures 34, 35, and 36 show the DOT input, the first two tables of the Herron input, and the output for the first three cadaver segments respectively.

No further analyses of the biostereometric data has been planned, pending discussions with Dr. Herron at the Biostereometrics laboratory regarding his data.

Each punched card corresponds to one line of the data in the tables. The first two numbers of the cards represent the table number and the data line of that table, respectively. The numbers that follow are the same as those of the data in the tables. (Disregard the last 8 digits of each pink card.)

For example a card with: 34 19 3 1206388.6 1491387.0 3717724.4

is from the 34th table, the 19th data line (column headings, titles, and subtitles were not numbered) and the next 4 fields are the data.

Twelve different formats were used for the cards:

Format #	Table #
1	Table 1, lines 1-16
2	Table 1, lines 17-22
3	Tables 2-7, odd lines
4	Tables 2-7, even lines
5	Table 8
6	Tables 9,13,17,21,25,29,33,37,41,45,49,53,57,61,65, 69,73,77
7	Tables 10-80, except those listed above
8	Tables 81-116, lines 1,4,7,10,13,16,19,22,25
9	Tables 81-116, all other lines
10	Tables 117,119,121
11	Tables 118,120,122
12	All table titles, subtitles, column headings

The Fortran coding for the above formats is as follows:

```
Format (1)    I3,I6,3X,I2,F27.3,2F16.3
Format (2)    I3,I6,3X,I2,F27.3,F16.3,F6.3,F10.3,F6.3
Format (3)    I3,I6,3X,I2,F10.1,F12.2,F13.1,F10.1,F12.1
Format (4)    I3,I6,25X,F15.1,F10.1,F12.1
Format (5)    I3,I6,3X,I2,F17.1,F6.1,F7.1,F13.1,F6.1,F7.1
Format (6)    I3,I6,3X,I2,F10.3,F10.1,F9.2,F11.1,F8.1,F9.1
Format (7)    I3,I6,3X,I2,F17.1,F20.1,F20.1
Format (8)    I3,I6,3X,I2,F17.10,2F20.10
Format (9)    I3,I6,5X,F17.10,2F20.10
Format (10)   I3,I6,3X,I2,F14.1,F17.1,F16.1,F14.1
Format (11)   I3,I6,3X,I2,F12.2,F14.2,F16.2,F15.2
Format (12)   20A4
```

Figure 32. Format Information for Herron's Data (Reference 8).

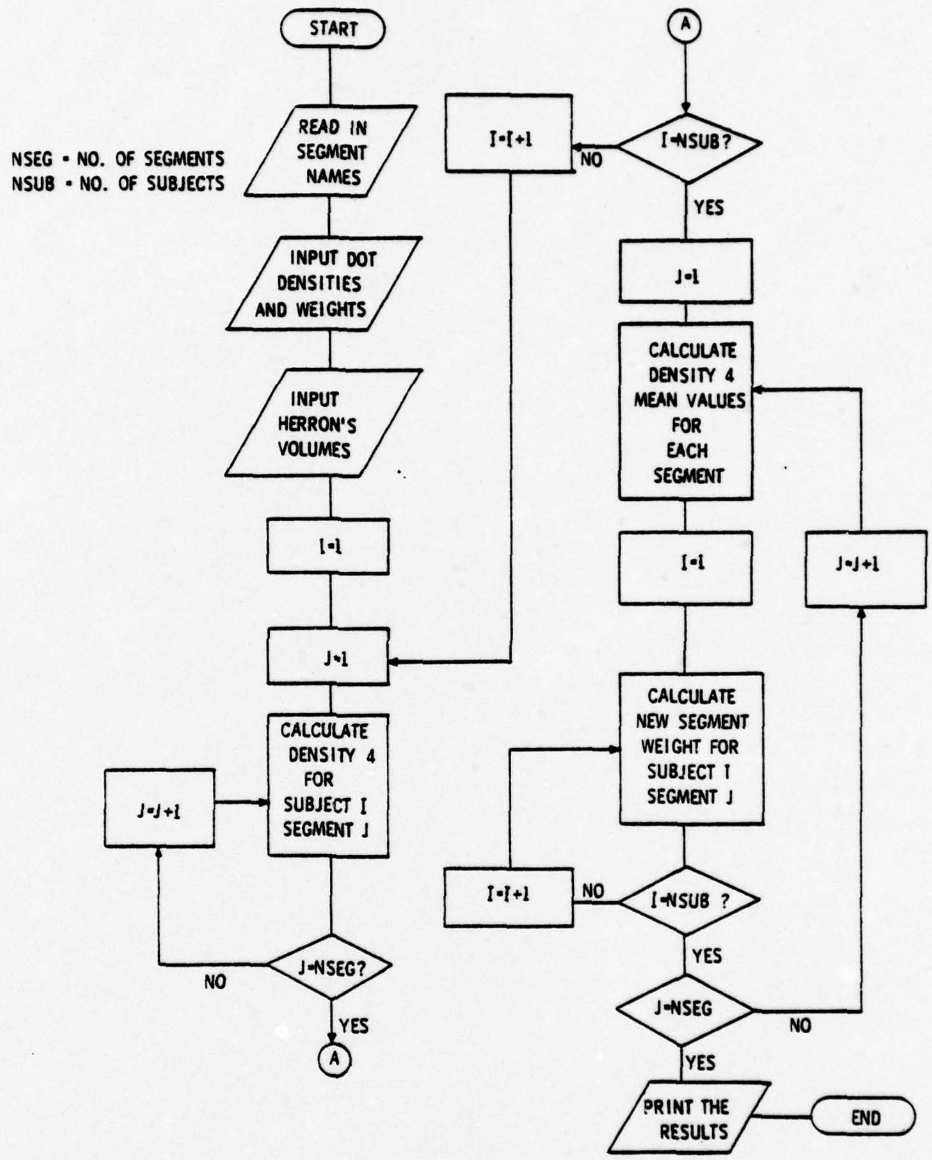


Figure 33. General Flow of Program HER1.

```
 1 HEAD
 2 R UPPER ARM
 3 R FOREARM
 4 R HAND
 5 L UPPER ARM
 6 L FOREARM
 7 L HAND
 8 R THIGH
 9 R CALF
10 R FOOT
11 L THIGH
12 L CALF
13 L FOOT
14 TORSO
15 WHOLE BODY
```

	SUBJECT 1		SUBJECT 2		SUBJECT 3		SUBJECT 4		SUBJECT 5		SUBJECT 6	
1	1055	4025	1046	4152	1096	4821	1052	5358	1055	4105	1030	3471
2	1067	1794	1063	1941	981	2248	983	1536	1012	1615	957	1719
3	1061	971	1017	1293	1035	1624	1051	796	1066	1011	1029	985
4	1105	563	1062	490	1037	552	1077	520	1086	555	1056	302
5	1033	1867	1004	2103	988	2404	1002	1536	1010	1580	1025	1619
6	1094	1002	1050	1170	1037	1418	1029	839	1061	957	1067	1149
7	1091	324	1063	409	1072	497	1075	326	1080	351	1058	332
8	1021	5601	1016	7294	1021	9770	1034	4153	1022	6612	995	5532
9	1062	2152	1054	2876	1073	3779	1052	2251	1057	2744	1057	2282
10	1055	791	1059	1029	1086	956	1054	730	1057	859	1107	857
11	1035	5839	1013	8082	1020	9399	1017	5606	1001	6090	1038	5733
12	1097	2288	1049	3039	1069	3794	1074	2056	1043	2510	1093	2345
13	1109	807	1038	1074	1092	974	1057	726	1055	765	1065	671
14	833	30631	877	41060	911	46132	792	26826	831	28005	857	31262
		58700		76150		89150		50820		56030		56340

Figure 34. Input from Report DOT-HS-801:430 Variable Names and Density/Weight Values for Each Segment (Reference 9).

			TABLE 9		SUBJECT 1			DENSITY 1	00000100
					MASS AND CENTER OF GRAVITY	(UNITS' C.G.S.)			00000200
			DENSITY	MASS	MASS	X C.G.	Y C.G.	Z C.G.	00000300
		SEGMENTS							00000400
9	1	1	1.000	4041.0	6.47	-.7	2.0	56.9	00000500
9	2	2	1.000	26901.1	43.06	-.6	-1.1	21.8	00000600
9	3	3	1.000	6774.2	10.84	.5	1.0	-11.1	00000700
9	4	4	1.000	1926.7	3.08	21.6	-5.2	28.1	00000800
9	5	5	1.000	963.1	1.54	33.8	-4.4	5.4	00000900
9	6	6	1.000	410.2	.66	33.3	-.4	-14.6	00001000
9	7	7	1.000	2017.4	3.23	-23.0	-4.2	28.9	00001100
9	8	8	1.000	941.8	1.51	-31.8	-2.7	5.9	00001200
9	9	9	1.000	347.9	.56	-34.5	.9	-15.8	00001300
9	10	10	1.000	6206.9	9.93	12.0	1.0	-30.5	00001400
9	11	11	1.000	2212.2	3.54	16.1	2.2	-71.8	00001500
9	12	12	1.000	811.5	1.30	17.5	8.8	-100.2	00001600
9	13	13	1.000	5950.3	9.52	-10.4	1.4	-31.6	00001700
9	14	14	1.000	2204.6	3.53	-13.7	2.7	-71.5	00001800
9	15	15	1.000	771.6	1.23	-15.4	3.7	-59.9	00001900
9	16	16	1.000	33675.3	53.90	-.4	-.7	15.2	00002000
		PARTS							00002100
9	17	1	1.000	37716.3	60.36	-.5	-.4	19.7	00002200
9	18	2	1.000	3300.0	5.28	25.7	-4.3	16.2	00002300
9	19	3	1.000	3307.1	5.29	-26.7	-3.2	17.6	00002400
9	20	4	1.000	9230.6	14.77	11.5	2.0	-46.5	00002500
9	21	5	1.000	8926.5	14.29	-11.7	2.3	-47.5	00002600
		WHOLE BODY							00002700
9	22	1	1.000	62480.4	100.00	.0	.0	.0	00002800

			TABLE 21		SUBJECT 2			DENSITY 1	00037400
					MASS AND CENTER OF GRAVITY	(UNITS' C.G.S.)			00037500
			DENSITY	MASS	MASS	X C.G.	Y C.G.	Z C.G.	00037600
		SEGMENTS							00037700
21	1	1	1.000	4190.4	5.33	.1	1.8	62.0	00037800
21	2	2	1.000	34681.5	44.07	.0	-1.5	24.9	00037900
21	3	3	1.000	8156.3	10.37	.0	.7	-9.0	00038000
21	4	4	1.000	2109.5	2.68	24.0	-3.0	30.6	00038100
21	5	5	1.000	1165.6	1.48	34.5	-2.9	4.9	00038200
21	6	6	1.000	494.1	.63	42.4	.7	-17.0	00038300
21	7	7	1.000	2328.4	2.96	-24.1	-5.3	33.5	00038400
21	8	8	1.000	1160.0	1.47	-30.1	-3.8	6.1	00038500
21	9	9	1.000	422.6	.54	-41.1	-.5	-15.0	00038600
21	10	10	1.000	7582.4	9.64	11.6	1.7	-31.5	00038700
21	11	11	1.000	2667.0	3.07	14.5	4.2	-77.0	00038800
21	12	12	1.000	1096.5	1.39	14.6	9.2	-109.9	00038900
21	13	13	1.000	8278.9	10.52	-10.7	1.2	-30.8	00039000
21	14	14	1.000	3016.1	3.83	-13.6	3.5	-77.6	00039100
21	15	15	1.000	1113.5	1.42	-12.9	10.3	-110.2	00039200
21	16	16	1.000	42837.9	54.44	.0	-1.1	18.5	00039300
		PARTS							00039400
21	17	1	1.000	47034.3	59.77	.0	-.9	22.4	00039500
21	18	2	1.000	3769.4	4.79	29.7	-2.5	16.4	00039600
21	19	3	1.000	3911.1	4.97	-29.5	-4.4	20.7	00039700
21	20	4	1.000	11566.4	14.70	12.6	3.0	-50.3	00039800
21	21	5	1.000	12409.6	15.77	-11.6	2.9	-45.5	00039900
		WHOLE BODY							00040000
21	22	1	1.000	78689.7	100.00	.0	.0	.0	00040100

Figure 35. First Two Tables of Herron's Data Input for HER1.

DENSITY COT AND OLD WEIGHT ARE FROM DOT HS-801 430
HERRON'S VOLUMES ARE THE MASS VALUES FROM HIS MASS AND CENTER OF
GRAVITY TABLES WITH DENSITY=1.0
DENSITY 4 WAS CALCULATED FROM THE OLD WEIGHTS AND HERRON'S VOLUMES
THE NEW WEIGHTS WERE CALCULATED FROM THE DENSITY 4 MEAN VALUES AND
HERRON'S VOLUMES

SUBJECT	DENSITY COT	DENSITY 4	HERRON'S VOLUME	OLD WEIGHT	NEW WEIGHT
1	1.0550	0.9960	4041.0	4025.0	4079.7
2	1.0460	0.9894	4196.4	4152.0	4236.6
3	1.0500	1.0591	4552.1	4021.0	4595.7
4	1.0520	1.0380	3235.1	3358.0	3266.1
5	1.0550	0.9882	4154.0	4105.0	4194.3
6	1.0300	0.9868	3517.6	3471.0	3551.3

THE HEAD DENSITY 4 MEAN VALUE IS 1.0096

SUBJECT	DENSITY COT	DENSITY 4	HERRON'S VOLUME	OLD WEIGHT	NEW WEIGHT
1	1.0070	0.9311	1926.7	1794.0	1764.4
2	1.0030	0.9201	2109.5	1941.0	1931.8
3	0.9810	0.9187	2446.9	2248.0	2240.7
4	0.9830	0.8845	1738.8	1538.0	1592.3
5	1.0120	0.9225	1967.4	1815.0	1801.6
6	0.9970	0.9174	1873.7	1719.0	1715.8

THE R UPPER ARM DENSITY 4 MEAN VALUE IS 0.9157

SUBJECT	DENSITY COT	DENSITY 4	HERRON'S VOLUME	OLD WEIGHT	NEW WEIGHT
1	1.0610	1.0082	963.1	971.0	968.3
2	1.0170	1.1691	1105.3	1293.0	1172.2
3	1.0350	0.9966	1625.4	1624.0	1634.6
4	1.0510	[illegible]	[illegible]	796.0	832.5
5	1.0660	0.9791	1032.5	1011.0	1038.2
6	1.0290	0.9761	1009.1	985.0	1014.6

THE R FORFARM DENSITY 4 MEAN VALUE IS 1.0054

Figure 36. HER1 Output.

SECTION 6

THE AEROSPACE MEDICAL RESEARCH LABORATORY DATA BANK AND RELATED MATERIALS

Since the formulation of the AMRL Data Bank, five anthropometric data tapes have been documented and published in AMRL Technical Reports, several others are near publication form, and several programs are now being prepared for publication as AMRL Technical Reports. Two publications, referenced later in this section, have been submitted which fully document four anthropometric survey data tapes, and the correlation tape which contains correlation information for seven anthropometric surveys. Also two correlation tapes of a comparison format, each containing two groups of survey data, which were prepared independent of the AMRL Data Bank are described.

6.1 THE AMRL DATA BANK LIBRARY OF COMPUTER PROGRAMS

Work is progressing steadily on the library of computer programs. A large portion of the documentation has been written and several programs await final touchup, including the XVAL and MSDP programs. Work towards completion of this library is at this time picking up speed. The programs, with complete documentation, will be published during the coming year as part of an AMRL Technical Report.

6.2 THE AMRL DATA BANK TAPE LIBRARY

The standardization of the AMRL Data Bank Tape Library is progressing steadily. Five tapes have been fully documented and published in AMRL-TR-77-2 in September 1976 (see Reference 10). The first four tape volumes in the Technical Report contain the basic survey data from the four most important USAF anthropometric surveys: the 1950 and 1967 surveys of flying personnel, the 1968 survey of Air Force Women, and the 1965 survey of male personnel. The fifth tape is the tape of U.S. correlations which is documented in Paragraph 6.3 of this report.

6.2.1 Tape Format

Since the AMRL report on these tapes is rather complete, this report will only attempt to familiarize the reader with their basic format and content. These tapes have been prepared in essentially a common format for ease in their use not only in AMRL, but in research efforts elsewhere as well. All records on the tape are in 80-character card-image form. The tapes have been made relatively self-explanatory in as much as only one format statement to read in text and other format statements contained in the tape, need be supplied by the user. Each tape contains a heading record, an identification record, a small amount of historical background information on the data, coding information, data variable names, ranges, suitable interval widths for frequency tables, conversion factors for the data, and all but one format statement for reading the tape. Several relevant constants are also provided in the third record of each tape. Figures 37a-f show a listing of the first five subjects of the 1968 USAF female personnel survey tape. The text explaining the different sections of the tape is quoted directly from AMRL-TR-77-2.

6.2.2 Summary

Since the publication of the AMRL Technical Report on the first five volumes of the Data Bank Tape library, nine other tapes are in near-standard form, lacking only historical background and coding information. These nine and several others will be completed during the next contract period.

6.3 INTERCORRELATIONS OF ANTHROPOMETRIC MEASUREMENTS

Three correlation tapes have been prepared during the past year. Two of them have been comparison oriented tapes, each containing the information from two different correlation matrices. The third tape contains eleven files of correlation matrices based on data from seven large U.S. anthropometric surveys.

```
REC 0001.. **    AMRL DATA BANK LIBRARY - VOLUME I - 1964 SURVEY OF AIR FORCE WOMEN    **
```

Line 1, as it appears, is simply the name of the survey. This is repeated as the last line of the tape heading so that it can be used as a heading for any output generated by the use of this tape.

```
REC 0002.. (6(9H          ,I4))
```

Line 2 is a format statement for reading in and writing out the next line.

```
REC 0003.. NSURVEY= 101;  NVO = 140;  NVT = 156;  NSB = 1905;  NLS =  47;NDATE = 7608
```

Line 3 provides several constants relevant to the contents of the tape:

- NSURVEY - an identifying number for the survey; here, NSURVEY=101
- NVØ - the number of ordinal variables; NVØ=140.
- NVT - the total number of variables; NVT-156.

(Non-ordinal variables always follow the ordinal ones.)

- NSB - the number of subjects; NSB=1905.
- NLS - the number of lines of the description of the survey and its coding; NLS=43.
- NDATE - the date at which this tape was prepared; NDATE=7608, i.e., August 1976.

```
REC 0004.. (I4,2X,2A9,3F8.2,2F6.2,2F10.7)
REC 0005.. (I4,2X,3A6,3F8.2,2F6.2,2F10.7)
REC 0006.. (I4,2X,4A4,A2,3F8.2,2F6.2,2F10.7)
```

Lines 4, 5, and 6 are three alternate formats for use in reading in the name-range-conversion constant records. The first of these reads in the name as two 9-character words, the second as three 6-character words, and the third a four 4-character and one 2-character words. The user of these tapes will presumably use the format most appropriate for his computer, or simply use the last of the three.

Figure 37a. The Heading and Identification Records and Some Formats (Reference 10).

The next several lines (i.e., NLS lines) are background material of some value, we hope, to the user of the tape's data but irrelevant to the computer's treatment of these data. The last of these NLS lines is a repeat of the initial line.

```
REC 0007.. THE SURVEY OF WOMEN OF THE AIR FORCE WAS MADE IN THE SPRING OF 1968 BY THE ANTH
REC 0008.. ROPOLOGY BRANCH, AEROSPACE MEDICAL RESEARCH LABORATORY, WRIGHT-PATTERSON AFB, O
REC 0009.. HIO AND THE ANTHROPOLOGY RESEARCH PROJECT(THEN AT ANTIOCH COLLEGE, YELLOW SPRIN
REC 0010.. GS, OHIO).  DATA FOR AGE(VARIABLE 1), 123 BODY SIZE MEASUREMENTS(VARIABLES 2-12
REC 0011.. 4), AND GRIP STRENGTH(VARIABLE 125) WERE OBTAINED FROM A SAMPLE OF 1905 WOMEN.
REC 0012.. 13 MEASUREMENTS WERE REPEATED ON 1513 SUBJECTS WITH THE SUBJECTS WEARING FOUNDA
REC 0013.. TION GARMENTS(VARIABLES 126-138).  AGE, AGE AT MENARCHE, AND YEAR OF BIRTH(AFTE
REC 0014.. R 1900) ARE RECORDED IN TENTHS OF YEARS; YEAR OF MEASUREMENT(AFTER 1900) IN HUN
REC 0015.. DREDTHS OF YEARS.  SKINFOLDS ARE RECORDED IN TENTHS OF MILLIMETERS, WEIGHT AND
REC 0016.. REPORTED WEIGHT IN POUNDS, REPORTED STATURE IN INCHES, GRIP STRENGTH IN KILOGRA
REC 0017.. MS.  ALL OTHER METRIC VARIABLES WERE RECORDED IN MILLIMETERS.
REC 0018.. CODED VARIABLES----
REC 0019.. 1.AGE
REC 0020..   AS REPORTED PLUS 0.5
REC 0021.. 141.FOUNDATION GARMENT
REC 0022..   1-REGULAR PANTY GIRDLE / 2-LONG LEG PANTY GIRDLE / 3-REGULAR GIRDLE / 4-LONG
REC 0023..   LEG GIRDLE / 5-CORSET / 6-PANTY / 7-MISCELLANEOUS OR NOT SPECIFIED /
REC 0024.. 142.AIR FORCE SPECIALTY CODE (SEE TAPE BOOKLET)
REC 0025.. 143.MARITAL STATUS
REC 0026..   1-SINGLE / 2-MARRIED / 3-DIVORCED / 4-OTHER /
REC 0027.. 145.RANK
REC 0028..   11-BASIC AIRMAN / 12-AIRMAN / 13-AIRMAN FIRST CLASS / 14-SERGEANT / 15-STAFF
REC 0029..   SERGEANT / 16-TECHNICAL SERGEANT / 17-MASTER SERGEANT / 18-SENIOR MASTER
REC 0030..   SERGEANT / 21-OFFICER TRAINEE / 31-2D LT / 32-1ST LT / 33-CAPTAIN / 34-MAJOR/
REC 0031..   35-LT-COL / 36-COLONEL /
REC 0032.. 146.COMMAND
REC 0033..   1-AFSC / 2-AFLC / 3-ATC / 4-SAC / 5-ADC / 6-TAC /
REC 0034.. 147.LOCATION
REC 0035..   1-CARSWELL / 2-LACKLAND / 3-RANDOLPH / 4-SHEPPARD / 5-WRIGHT-PATTERSON /
REC 0036..   6-SEWARD /
REC 0037.. 148.BLOOD TYPE
REC 0038..   1-A / 2-B / 3-AB / 4-O /
REC 0039.. 149.RH FACTOR
REC 0040..   1-NEG / 2-POS /
REC 0041.. 150.HANDEDNESS
REC 0042..   1-RIGHT / 2-LEFT / 3-AMBIDEXTROUS /
REC 0043.. 151-153.BIRTHPLACE(SUBJECT,FATHER, AND MOTHER)
REC 0044..  11-MAINE / 12-NEW HAMP / 13-VERMONT / 14-MASS / 15-RHODE IS / 16-CONN / 21-NEW
REC 0045..  YORK / 22-NEW JERSEY / 23-PENN / 31-DELAWARE / 32-MARYLAND/ 33-DC/ 34-VIRGINIA
REC 0046..  41-OHIO / 42-INDIANA / 43-ILLINOIS / 44-MICHIGAN / 45-WISCONSIN / 51-KENTUCKY
REC 0047..  52-TENNESSEE / 53-MISSISSIPPI / 54-ALABAMA / 61-MINNESOTA / 62-IOWA
REC 0048..  63-MISSOURI / 64-N DAKOTA / 65-S DAKOTA / 56-NEBRASKA / 67-KANSAS / 71-ARKANAS
REC 0049..  72-LOUISIANA / 73-OKLAHOMA / 74-TEXAS / 81-MONTA A / 82-IDAHO / 83-WYOMING
REC 0050..  84-COLORADO / 85-UTAH / 86-NEVADA / 87-ARIZONA / 88-N MEXICO / 91-CALIFORNIA
REC 0051..  92-OREGON / 93-WASHINGTON / 94-ALASKA / 95-HAWAII / SEE TAPE BOOKLET FOR
REC 0052..   FOREIGN CODES. /
REC 0053.. **     AMRL DATA BANK LIBRARY - VOLUME I - 1968 SURVEY OF AIR FORCE WOMEN     **
```

Figure 37b. The Historical Background and Coding Information (Reference 10).

The following NVT (as read from line 3) lines provide information about each variable: names, ranges, conversion constants, and the like. This information can be ignored, in whole or part, by both the human users of these tapes and the computers. The I-th of these lines contains, in order:

I,(Name(I,L),L=1,NLGTH),(A(I,L),L=1,7)

where NLGTH is the length of the name in words. NLGTH depends on the computer word length and must be supplied by the user of the tape.

The quantities A(I,L) are these--we illustrate using the values for weight:

A(I,1)=82.50 a value slightly lower than the smallest value of weight recorded. This value was selected as an appropriate lower limit for the first interval when weights are grouped for frequency tables containing up to but not in excess of 50 intervals.

A(I,2)=200.00 the largest weight recorded.

A(I,3)=126.00 an approximation to the mean weight, included for use in reducing the size of summations of squares and higher powers.

A(I,4)=3.00 a suggested interval width for frequency tables which are limited to a maximum of 50 intervals. In this case, a table of 40 intervals will result; an interval of 2 pounds would have been too fine, and would have resulted in almost 60 intervals. Intervals for linear measurement have generally been restricted to values of 1, 2, 5, 10, 15 or 20 mm.

A(I,5)=5.00 a suggested interval width for frequency tables which are limited to a maximum of 30 intervals.

A(I,6)=0.4535924 a constant to convert the summary statistics from the units in which they were measured to the desired metric units for output. Here the conversion is from pounds to kilograms. Since the measurements are generally made in metric units, the function of A(I,6) is usually to adjust the location of the decimal point.

A(I,7)=2.2046223 a constant to convert the metric output to English units. For weight, this constant converts from kilograms back into pounds.

Figure 37c. The Variable Name-Range Records (Reference 10).

REC 0054..	1	AGE	18000	57500	23000	1000	2000	1000000	10000000
REC 0055..	2	WEIGHT	8250	20000	12600	300	500	4535924	22046223
REC 0056..	3	TRICEP" SKINFOLD	5250	46800	18000	1000	2000	100000	3937008
REC 0057..	4	SUBSCAPULAR SKINFD	4250	37200	12000	1000	2000	100000	3937008
REC 0058..	5	SUPRAILIAC SKINFLD	4250	50000	19000	1000	2000	100000	3937008
REC 0059..	6	MEDIAL CALF SKINFD	1250	37200	15000	1000	2000	100000	3937008
REC 0060..	7	STATURE	144250	183000	162000	1000	2000	1000000	3937008
REC 0061..	8	STATURE, MAXIMUM	144250	184000	162000	1000	2000	1000000	3937008
REC 0062..	9	CERVICALE HEIGHT	120250	156800	139000	1000	2000	1000000	3937008
REC 0063..	10	ACROMIAL HEIGHT	114250	152000	131000	1000	2000	1000000	3937008
REC 0064..	11	SUPRASTERNALE HGHT	116250	150600	131000	1000	2000	1000000	3937008
REC 0065..	12	BUST POINT HEIGHT	100250	136300	115000	1000	2000	1000000	3937008
REC 0066..	13	WAIST HEIGHT	86250	115500	100000	1000	2000	1000000	3937008
REC 0067..	14	ABDOMINAL EXT HGT	78250	108000	93000	1000	2000	1000000	3937008
REC 0068..	15	TROCHANTERIC HGHT	68250	96500	82000	1000	2000	1000000	3937008
REC 0069..	16	BUTTOCK HEIGHT	64250	96600	82000	1000	2000	1000000	3937008
REC 0070..	17	GLUTEAL FURROW HGT	58250	86400	72000	1000	2000	1000000	3937008
REC 0071..	18	TIBIALE HEIGHT	33250	49600	41000	500	1000	1000000	3937008
REC 0072..	19	CROTCH HEIGHT	60250	87500	74000	1000	2000	1000000	3937008
REC 0073..	20	ANKLE HEIGHT	7250	16000	11000	500	500	1000000	3937008
REC 0074..	21	LAT"L MALLEOLUS HT	4750	8700	5700	500	500	1000000	3937008
REC 0075..	22	SITTING HT,RELAXED	73250	96000	84000	500	1000	1000000	3937008
REC 0076..	23	SITTING HEIGHT	75250	96400	85500	500	1000	1000000	3937008
REC 0077..	24	EYE HEIGHT,SITTING	63250	83100	73600	500	1000	1000000	3937008
REC 0078..	25	MIDSHOULDER HT,SIT	50250	67200	57600	500	1000	1000000	3937008
REC 0079..	26	WAIST HGHT,SITTING	17750	29200	23100	500	500	1000000	3937008
REC 0080..	27	ELBOW REST HEIGHT	14250	29500	22500	500	1000	1000000	3937008
REC 0081..	28	POPLITEAL HEIGHT	33250	47100	40800	500	1000	1000000	3937008
REC 0082..	29	BUTTOCK-POPLIT"L L	38250	58500	47600	500	1000	1000000	3937008
REC 0083..	30	BUTTOCK-KNEE LNGTH	48250	66400	57200	500	1000	1000000	3937008
REC 0084..	31	ACROMION-RADIALE L	25250	36500	30900	500	500	1000000	3937008
REC 0085..	32	RADIALE-STYLION L	18750	28000	23200	500	500	1000000	3937008
REC 0086..	33	THUMB-TIP REACH	62250	87200	74000	1000	1000	1000000	3937008
REC 0087..	34	THUMB-TIP,EXTENDED	70250	100000	83000	1000	2000	1000000	3937008
REC 0088..	35	OVERHEAD REACH	174250	227600	198000	1500	3000	1000000	3937008
REC 0089..	36	NECK CIRCUMFERENCE	26250	39900	33600	500	500	1000000	3937008
REC 0090..	37	SHOULDER CIRCUMFER	86250	122100	100000	1000	2000	1000000	3937008
REC 0091..	38	CHEST CIRC AT SCYE	70250	103500	84000	1000	2000	1000000	3937008
REC 0092..	39	BUST CIRCUMFERENCE	74250	113900	89000	1000	2000	1000000	3937008
REC 0093..	40	CHEST C BELOW BUST	60250	97000	74000	1000	2000	1000000	3937008
REC 0094..	41	WAIST CIRCUMFERNCE	52250	95100	67000	1000	2000	1000000	3937008
REC 0095..	42	ABDOMI"AL EXT CIRC	64250	119000	85500	1500	2500	1000000	3937008
REC 0096..	43	HIP C-7""BLW WAIST	76250	117000	93000	1000	2000	1000000	3937008
REC 0097..	44	HIP C-9""BLW WAIST	76250	120100	95000	1000	2000	1000000	3937008
REC 0098..	45	UPPER THIGH CIRCUM	42250	72000	55000	1000	2000	1000000	3937008
REC 0099..	46	KNEE CIRCUMFERENCE	30250	45700	36000	500	1000	1000000	3937008
REC 0100..	47	CALF CIRCUM, RIGHT	26250	44500	34000	500	1000	1000000	3937008
REC 0101..	48	CALF CIRCUM, LEFT	26250	44000	34000	500	1000	1000000	3937008
REC 0102..	49	ANKLE CIRCUMFERNCE	17250	25600	21000	500	500	1000000	3937008
REC 0103..	50	VERTICAL TRUNK CIR	134250	178200	154000	1000	2000	1000000	3937008
REC 0104..	51	VERTICAL TRK C,SIT	132250	170500	150000	1000	2000	1000000	3937008
REC 0105..	52	BUTTOCK CIRC, SIT	94250	128400	99000	1000	2000	1000000	3937008
REC 0106..	53	SCYE CIRCUMFERENCE	28250	49000	37000	500	1000	1000000	3937008
REC 0107..	54	AXILLARY ARM CIRC	20250	39100	27200	500	1000	1000000	3937008
REC 0108..	55	BICEPS C,RELAXED,R	19250	37400	25200	500	1000	1000000	3937008
REC 0109..	56	BICEPS C,FLEXED, R	19250	39000	25400	500	1000	1000000	3937008
REC 0110..	57	BICEPS C,RELAXED,L	19250	37800	25600	500	1000	1000000	3937008
REC 0111..	58	BICEPS C,FLEXED, L	19250	39200	25400	500	1000	1000000	3937008
REC 0112..	59	ELBOW CIRC, FLEXED	21250	35800	26700	500	1000	1000000	3937008
REC 0113..	60	FOREARM C, RELAXED	19250	30000	23400	500	500	1000000	3937008
REC 0114..	61	FOREARM C, FLEXED	19250	32800	24900	500	1000	1000000	3937008
REC 0115..	62	WRIST CIRCUMFERNCE	12250	17600	14800	500	500	1000000	3937008
REC 0116..	63	BIACROMIAL BREADTH	30750	41600	35700	500	500	1000000	3937008
REC 0117..	64	BIDELTOID BREADTH	34250	50100	41700	500	1000	1000000	3937008
REC 0118..	65	CHEST BREADTH	22250	35900	27900	500	1000	1000000	3937008
REC 0119..	66	BUST PT-BUST PT BR	12750	24600	18300	500	500	1000000	3937008
REC 0120..	67	WAIST BREADTH	18250	32700	24000	500	1000	1000000	3937008
REC 0121..	68	HIP BREADTH	28250	44100	34800	500	1000	1000000	3937008
REC 0122..	69	THIGH-THIGH BR,SIT	28250	50200	38000	500	1000	1000000	3937008
REC 0123..	70	HUMERAL BREADTH, R	5150	7500	6100	100	100	1000000	3937008

Figure 37d. (Reference 10).

REC 0124..	71	HUMERAL BREADTH, L	5150	7400	6100	100	100	1000000	3937008
REC 0125..	72	FEMORAL BREADTH, R	6650	9900	8100	200	200	1000000	3937008
REC 0126..	73	FEMORAL BREADTH, L	6650	9900	8100	200	200	1000000	3937008
REC 0127..	74	CHEST DEPTH	18250	32300	23400	500	1000	1000000	3937008
REC 0128..	75	WAIST DEPTH	12250	25500	16800	500	1000	1000000	3937008
REC 0129..	76	ABDOMINAL EXT DPTH	15250	30300	20700	500	1000	1000000	3937008
REC 0130..	77	BUTTOCK DEPTH	15250	30600	21000	500	1000	1000000	3937008
REC 0131..	78	THIGH CLEARANCE	6750	16900	12400	500	500	1000000	3937008
REC 0132..	79	SHOULDER LENGTH	11250	18800	14600	500	500	1000000	3937008
REC 0133..	80	NECK-BUST POINT L	19250	32000	25200	500	1000	1000000	3937008
REC 0134..	81	STRAP LENGTH	52250	79700	65000	1000	2000	1000000	3937008
REC 0135..	82	INTERSCYE	27250	44200	34800	500	1000	1000000	3937008
REC 0136..	83	INTERSCYE, MAXIMUM	37250	60500	49000	500	1000	1000000	3937008
REC 0137..	84	BACK CURVATURE	33250	53500	42000	500	1000	1000000	3937008
REC 0138..	85	WAIST BACK	33250	48100	40500	500	1000	1000000	3937008
REC 0139..	86	ANTERIOR WAIST LTH	27250	41500	33300	500	1000	1000000	3937008
REC 0140..	87	SLEEVE INSEAM	36250	53500	44000	500	1000	1000000	3937008
REC 0141..	88	SPINE-TO-SCYE LGTH	15250	25500	20100	500	500	1000000	3937008
REC 0142..	89	SPINE-TO-ELBOW LTH	44250	62500	53200	500	1000	1000000	3937008
REC 0143..	90	SPINE-TO-WRIST LTH	67250	91200	79500	500	1000	1000000	3937008
REC 0144..	91	HAND LENGTH	15250	22000	18200	200	500	1000000	3937008
REC 0145..	92	HAND BREADTH	6650	8800	7500	100	200	1000000	3937008
REC 0146..	93	HAND CIRCUMFERENCE	14750	21500	18200	500	500	1000000	3937008
REC 0147..	94	FOOT LENGTH	20750	27600	24000	500	500	1000000	3937008
REC 0148..	95	FOOT BREADTH	6750	11000	8800	500	500	1000000	3937008
REC 0149..	96	HEAD LENGTH	16250	20700	18400	200	200	1000000	3937008
REC 0150..	97	HEAD BREADTH	12250	17100	14500	200	200	1000000	3937008
REC 0151..	98	HEAD CIRCUMFERENCE	49750	61700	54600	500	500	1000000	3937008
REC 0152..	99	TRAGION-TOP HEAD	10250	16100	12600	200	500	1000000	3937008
REC 0153..	100	ECTOCANTHUS-TOP HD	8250	15700	11600	200	500	1000000	3937008
REC 0154..	101	PRONASALE-TOP HEAD	10250	19300	14600	200	500	1000000	3937008
REC 0155..	102	SUBNASALE-TOP HEAD	12250	20500	15800	200	500	1000000	3937008
REC 0156..	103	STOMION-TOP HEAD	14250	23100	17800	200	500	1000000	3937008
REC 0157..	104	MENTON-TOP HEAD	18250	26800	21800	200	500	1000000	3937008
REC 0158..	105	TRAGION TO WALL	7250	14600	10000	200	500	1000000	3937008
REC 0159..	106	ECTOCANTHUS-WALL	13250	21200	16200	200	500	1000000	3937008
REC 0160..	107	PRONASALE TO WALL	18250	25000	21000	200	500	1000000	3937008
REC 0161..	108	SUBNASALE TO WALL	16250	24000	19600	200	500	1000000	3937008
REC 0162..	109	LIP PROTRUS"N-WALL	16250	24100	19200	200	500	1000000	3937008
REC 0163..	110	MENTON TO WALL	14250	22900	18200	200	500	1000000	3937008
REC 0164..	111	SAGITTAL CURVATURE	29750	41500	34500	500	500	1000000	3937008
REC 0165..	112	BITRAGION-CORONAL	28750	39200	33900	500	500	1000000	3937008
REC 0166..	113	BIOCULAR BREADTH	7850	11200	9600	200	200	1000000	3937008
REC 0167..	114	BIAURICULAR BRDTH	13250	20100	15800	200	500	1000000	3937008
REC 0168..	115	BITRAGION BREADTH	11250	15200	12800	200	200	1000000	3937008
REC 0169..	116	BIZYGOMATIC BRDTH	10850	14900	12800	200	200	1000000	3937008
REC 0170..	117	BIGONIAL BREADTH	8050	12200	10100	200	200	1000000	3937008
REC 0171..	118	NASAL BREADTH	2250	4600	3100	200	200	1000000	3937008
REC 0172..	119	LIP LENGTH	3050	5800	4300	200	200	1000000	3937008
REC 0173..	120	MENTON-SUBNASALE L	3850	7500	5500	100	200	1000000	3937008
REC 0174..	121	MENTON-SELLION LTH	6650	12800	10600	100	200	1000000	3937008
REC 0175..	122	SUBNASALE-SELLION	3050	6100	4500	100	200	1000000	3937008
REC 0176..	123	EAR LENGTH	3450	6900	5200	100	200	1000000	3937008
REC 0177..	124	EAR BREADTH	1850	4200	2900	100	200	1000000	3937008
REC 0178..	125	GRIP STRENGTH	950	5300	2900	100	200	10000000	3937008
REC 0179..	126	WAIST HEIGHT, OFG	86250	115300	100000	1000	2000	1000000	3937008
REC 0180..	127	ABDOM EXT HGT, OFG	78250	107900	92000	1000	2000	1000000	3937008
REC 0181..	128	WAIST CIRCUM, OFG	54250	89000	66000	1000	2000	1000000	3937008
REC 0182..	129	ABDOM EXT CIRC,OFG	64250	118200	87000	1500	2500	1000000	3937008
REC 0183..	130	HIP C-7""BLW W,OFG	76250	118800	93000	1000	2000	1000000	3937008
REC 0184..	131	HIP C-9""BLW W,OFG	76250	120200	95000	1000	2000	1000000	3937008
REC 0185..	132	WAIST BREADTH, OFG	17250	30800	21300	500	1000	1000000	3937008
REC 0186..	133	HIP BREADTH, OFG	27250	42700	33600	500	1000	1000000	3937008
REC 0187..	134	WAIST DEPTH, OFG	11250	24700	15600	500	1000	1000000	3937008
REC 0188..	135	ABDOM EXT DPTH,OFG	13250	30200	19600	500	1000	1000000	3937008
REC 0189..	136	BUTTOCK DEPTH, OFG	16250	30400	21300	500	1000	1000000	3937008
REC 0190..	137	BUTTOCK C, SIT,OFG	82250	128800	99000	1000	2000	1000000	3937008
REC 0191..	138	THI-THI BR,SIT,OFG	28250	48300	37200	500	1000	1000000	3937008
REC 0192..	139	STATURE REPORTED	5750	7400	6400	100	100	25400050	3937008
REC 0193..	140	WEIGHT REPORTED	8150	19500	12000	500	500	4535924	22046223

Figure 37e. (Reference 10).

```
REC 0194.. 141  FOUNDATION GARMENT      50      900      300   100    100  10000000  10000000
REC 0195.. 142  AFSC                  8750  9912830  5558000 98500396500  10000000  10000003
REC 0196.. 143  RACE                    50      300      200   100    100  10000000  10000000
REC 0197.. 144  MARITAL STATUS          50      400      100   100    100  10000000  10000000
REC 0198.. 145  RANK (NUMERICAL)      1050     3600     1700   100    200  10000000  10000000
REC 0199.. 146  COMMAND                 50      600      200   100    100  10000000  10000000
REC 0200.. 147  LOCATION                50      600      200   100    100  10000000  10000000
REC 0201.. 148  BLOOD TYPE              50      400      200   100    100  10000000  10000000
REC 0202.. 149  RH FACTOR               50      200      100   100    100  10000000  10000000
REC 0203.. 150  HANDEDNESS              50      300      100   100    100  10000000  10000000
REC 0204.. 151  BIRTHPLACE,SUBJECT     -50    18000     4800  1000   1000  10000000  10000000
REC 0205.. 152  BIRTHPLACE,FATHER      -50    18000     4800  1000   1000  10000000  10000000
REC 0206.. 153  BIRTHPLACE,MOTHER      -50    18000     4800  1000   1000  10000000  10000000
REC 0207.. 154  YEAR OF BIRTH        11500    50500    50500  1000   1000  10000000  10000000
REC 0208.. 155  AGE AT MENARCHE       8500    20800    13000   500    500   1000000  10000000
REC 0209.. 156  YEAR MEASURED         3900     5200     4500   100    100    100000  10000000
REC 0210.. (I4,19F4.0/2(20F4.0/),2(25F3.0,F5.0/),20F4.0/9F4.0,F3.0,F6.0,8F2.0,5F3.0,F4.0)
```

At the end of the list of name-range-conversion unit records is the format statement for reading in the data. While the data were written on the tape in integer format to save space, the format statement provided assumes that everything except the subject number is to be treated as floating decimal values. This format statement is, therefore, not suitable for listing data read from the tape.

This material is followed by the data. Each data record consisting of a subject number (increasing but not always consecutive) followed by NVT data values. The last data record is followed by a pseudo-data record for which the subject number is negative. Thus the user can read in all the data by reading the data for NSB subjects or by reading data until a *negative subject number* is sensed. Care should be taken in reading the data until an end of file (EØF) is sensed to insure that the pseudo-data record is not treated as a normal data record.

```
REC 0211..   1 285 112 124  78  86 150156715811315126912511130 928 658 778 763 675 406 703
REC 0212.. 120  65 835 855 722 573 234 204 389 459 536 308 238 729 9021886 345 966 793 905
REC 0213.. 749 642 848 882 897 524 357 326 330 21115061474 945 343 252 228 239 229 232 231
REC 0214..22122814836139227619123333382 62 62 86 8525318322719912014325764934846242 5  376
REC 0215..33943919253280216 9 74179230 861831625651401221521631822231061662091951951 88  392
REC 0216.. 372  95 169 133 126  97  35  43  55 109  50  56  32  25 913 842 612 843 875 878
REC 0217.. 214 328 177 223 215 922 357  62 116   2  9754 2 132 2 5 4 2 1  9  9  9394125683 9
REC 0218..   2 315 127 182 106 108 1081624164114061310132711791000 937 830 800 764 405 738
REC 0219.. 113  60 850 873 769 603 261 255 397 476 585 307 235 745 9301953 345 996 845 922
REC 0220.. 741 669 820 943 986 508 358 338 332 19616121527105 0 391 279 251 257 260 263 252
REC 0221..2252371463604092881942393554 12 55 55 80 80254170204239142164270657352471395  419
REC 0222..3434342145418051 75 76171230 861851445391231071331461662091101712182022 02184  355
REC 0223.. 325  94 166 125 111  93  33  46  57 106  51  53  36  32 987 926 637 830 948 981
REC 0224.. 226 358 168 204 244 986 399  64 122   2  9754 2 232 2 5 3 2 1 43 42 413681556839
REC 0225..   3 455 126 160 164 326  681622163013751296130011 69 968 887 857 795 705 406 731
REC 0226.. 125  68 887 899 788 588 220 223 394 441 548 310 237 737 8411951 3601057 934 957
REC 0227.. 811 747 900 925 930 525 350 330 331 1951617155710 11 391 295 265 270 266 281 271
REC 0228..24225215537942032917727533337 6 62 60 76 752511832181881201592797143855504 51  420
REC 0229..359432221556818184 81_02242 871841505531221111401501672051011642101961941 84  373
REC 0230.. 351  97 160 132 130 111  32  42  54 106  46  60  35  33 969 902 718 886 911 909
REC 0231.. 260 335 185 221 216 995 362  64 126   3  9735 2 135 2 5 4 2 1 43 43 432271456839
REC 0232..   4 295 143 352 192 456 35216141619137012941293117 1 971 876 819 771 684 385 731
REC 0233.. 103  65 883 896 790 615 254 275 390 450 578 291 220 658 8801950 356 970 864 968
REC 0234.. 760 702 905 9701045 598 396 355 360 23016451564109 5 384 304 298 304 294 295 290
REC 0235..26027516036040730019825138242 3 63 62 85 872541832202331421552596623305043 94  415
REC 0236..357410201522765174 73183233 801811525701301111401481652091241832232132 08200  345
REC 0237.. 370 105 165 129 135 112  28  43  60 115  50  50  36  24   0   0   0   0   0   0
REC 0238..   0   0   0   0   0   0   0  65 144   7  9754 2 233 2 5 1 1 1 37 36 373931096839
REC 0239..   5 235 146 180 110 132 17017001707144213751386123310 37 958 866 954 777 461 794
REC 0240.. 127  77 876 901 784 614 261 235 433 475 605 327 240 754 9042032 3651065 890 950
REC 0241.. 779 702 890 9591000 593 385 364 359 22016341566103 8 380 286 274 291 271 280 280
REC 0242..24926615537343729718225535538 8 65 63 87 86252171217233155162276697355534 80  411
REC 0243..3604672055378121 93 80193249 921961525801351301671792002281051702212031951 83  383
REC 0244.. 336  98 176 133 126  95  28  48  60 114  50  57  25  371058 970 657 905 955 975
REC 0245.. 230 357 177 242 2531013 392  68 145   4  9754 2 232 2 5 1 1 1 41 41 414491356839
         .
         .
         .
         .
```

Figure 37f. The Subject Data Format and the Data Itself for the First Five Subjects (Reference 10).

6.3.1 Two Tapes for Comparison

The first two correlation tapes contain information from the 1968 USAF WOMEN survey versus 1967 USAF MEN survey, and from the 1965 USAF survey's black basic trainees versus white basic trainees. One hundred similar variables from the three surveys were chosen by Edmund Churchill of Webb Associates for the basis of these tapes. The first two records on the tape are 80-character card images and contain the formats needed for reading the tape. Header information is contained in the next three records which describe the layout of the variable names and statistical information. Original survey variable names are listed for each survey along with their survey numbers (SR NO), mean values for each variables (X-BAR), and standard deviations (SD). Both surveys are listed side-by-side, as shown in Figure 38, with the two right-most columns listing the arithmetic differences between X-BAR (DELTA XBAR) and SD(DELTA SD) for the two surveys for each variable. Following the variable names is a table, which is 22 card-image records long, which illustrates the layout of the correlations. The correlations for both surveys are listed in one 100X 100 element matrix. The diagonal elements of the matrix were all set to zero while the correlations of one survey occupy the upper right section of the matrix and those for the second survey the lower left section of the matrix. Figure 38 is a partial printout of the 1967 USAF MEN versus 1968 USAF WOMEN (WAF) tape. Thus far no analyses have been done using these two tapes.

6.3.2 U.S. Correlations

The third correlation tape of correlation matrices was documented and published in September 1976 in AMRL-TR-77-1 (see Reference11). The following is a portion of the abstract from that publication.

"Correlation matrices based on data from USAF anthropometric surveys of women (1968, 125 variables), flying personnel (1950, 128 variables; 1967, 190 variables), and basic trainees (1965, 161 variables); a U.S. Army survey of women separatees (1946, 60 variables); the Health Examination

(8A10,/,2(13A10,/),100(2(2I4,2X,2A9,2F11.5,5X),2F11.5),22(/))
(16F8.5)

THE 1967 USAF AND WAF CORRELATION FILE

SR NO		WAF NAME	X-BAR	SD	SR NO		1967 USAF NAME	X-BAR	SD	DELTA X-BAR	DELTA SD
1	1	AGE	22.92756	6.45184	1	1	AGE	30.02882	6.29563	-7.10126	.15621
2	2	WEIGHT	127.28189	16.56658	2	2	WEIGHT	173.57594	21.41646	-46.29405	-4.82988
3	3	TRICEPS SKINFOLD	190.32441	54.41558	4	3	SKF TRICEPS-LANGE	12.74211	5.13204	177.58230	49.28354
4	4	SUBSCAPULAR SKINFD	128.59108	48.47749	3	4	SKF SUBSCAP"R-LNGE	13.66639	5.33002	114.92469	43.14747
5	5	SUPRAILIAC SKINFLD	197.23465	70.12367	11	5	SKF SUPRAILIAC-HPN	242.16197	103.36749	-44.92732	-33.24382
7	6	STATURE	1621.03307	60.03850	13	6	HEIGHT (STATURE)	1773.53049	61.73432	-152.49742	-1.69582
9	7	CERVICALE HEIGHT	1391.95748	55.19079	14	7	CERVICALE HEIGHT	1520.74547	58.12487	-128.78799	-2.93409
10	8	ACROMIAL HEIGHT	1318.60053	54.79437	15	8	ACROMION HEIGHT	1452.19394	57.48096	-133.59341	-2.68659
11	9	SUPRASTERNALE HGHT	1320.01365	53.01889	19	9	SUPRASTERNALE HGHT	1452.04416	54.91285	-132.03051	-1.89396
12	10	BUST POINT HEIGHT	1183.18793	52.13736	20	10	NIPPLE HEIGHT	1292.59108	52.24976	-109.40315	-.11240
13	11	WAIST HEIGHT	1002.78740	44.98502	21	11	WAIST HT-OMPHALION	1064.82582	47.11151	-62.03842	-2.12649
15	12	TROCHANTERIC HGHT	826.72441	42.67776	24	12	TROCHANTERION HGHT	939.69036	43.46657	-112.96595	-.78881
16	13	BUTTOCK HEIGHT	822.12703	41.62904	23	13	BUTTOCK HEIGHT	901.19520	43.83550	-79.06816	-2.20646
17	14	GLUTEAL FURROW HGT	727.00840	39.61141	25	14	GLUTEAL FURROW HGT	811.27808	40.04578	-84.26968	-.43438
18	15	TIBIALE HEIGHT	419.82467	23.76293	28	15	KNEE CIRC HEIGHT	496.48001	24.85706	-76.65534	-1.09413
19	16	CROTCH HEIGHT	745.04409	40.29395	26	16	CROTCH HEIGHT	850.82288	41.44373	-105.77879	-1.14978
20	17	ANKLE HEIGHT	111.86719	13.54234	31	17	ANKLE HEIGHT	137.18763	11.48895	-25.32044	2.05339
21	18	LAT"L MALLEOLUS HT	67.73858	5.87042	132	18	LAT"L MALLEOLUS HT	70.39882	5.42078	-2.66024	.44964
23	19	SITTING HEIGHT	855.99948	31.68807	32	19	SITTING HEIGHT	931.82709	31.70558	-75.82761	-.01750
24	20	EYE HEIGHT,SITTING	737.04462	30.58081	33	20	EYE HEIGHT/SITTING	809.47833	30.12741	-72.43371	.45340
25	21	MIDSHOULDER HT,SIT	579.97638	26.58103	34	21	MIDSHOULDER HT/SIT	645.93774	27.40611	-65.96136	-.82508
27	22	ELBOW REST HEIGHT	227.06142	24.61521	36	22	ELBOW REST HGT/SIT	251.63904	26.07191	-24.57762	-1.45670
28	23	POPLITEAL HEIGHT	410.47454	18.60513	38	23	POPLITEAL HGHT/SIT	437.07404	22.40403	-26.59950	-3.79891
29	24	BUTTOCK-POPLIT"L L	477.10709	27.58567	40	24	BUTTOCK-POPLITEAL	503.83845	25.73078	-26.73136	1.85489
30	25	BUTTOCK-KNEE LNGTH	574.28137	26.33893	39	25	BUTTOCK-KNEE LNGTH	604.12157	26.97580	-29.84021	-.63687
31	26	ACROMION-RADIALE L	310.05932	16.25687	43	26	ACROMION-RADIALE L	329.47244	17.00262	-19.41312	-.74575
32	27	RADIALE-STYLION L	233.86667	13.68019	45	27	RADIALE-STYLION LH	268.83635	14.20863	-34.96968	-.52845
33	28	THUMB-TIP REACH	741.31234	38.76264	47	28	THUMB-TIP REACH	803.15986	39.75051	-61.84752	-.98787
34	29	THUMB-TIP,EXTENDED	838.33176	48.77919	48	29	THUMB-TIP R"CH/XTD	895.94194	45.15364	-57.61018	3.62554
36	30	NECK CIRCUMFERENCE	337.49344	16.76671	66	30	NECK CIRC -MAXIMUM	383.42406	19.12700	-45.93062	-2.36029
37	31	SHOULDER CIRCUMFER	1004.12703	51.38271	67	31	SHOULDER CIRCUM"CE	1176.91249	58.07640	-172.78546	-6.69369
39	32	CHEST CIRC AT SCYE	842.48976	49.63574	68	32	CHEST CIRC AT SCYE	1022.47917	60.56760	-179.98941	-10.93185
41	33	WAIST CIRCUMFERNCE	672.03202	54.76685	70	33	WAIST CIR-OMPHAL"N	875.95456	73.67513	-203.92254	-18.90828
45	34	UPPER THIGH CIRCUM	554.75381	42.19422	96	34	UPPER THIGH CIRCUM	588.15313	44.32350	-33.39932	-2.12928
46	35	KNEE CIRCUMFERENCE	363.01470	22.65447	98	35	KNEE CIRCUMFERENCE	386.74716	20.74432	-23.73246	1.91015
47	36	CALF CIRCUM, RIGHT	341.43570	22.46598	100	36	CALF CIRCUMF/RIGHT	371.91418	22.73158	-30.47848	-.26560
49	37	ANKLE CIRCUMFERNCE	210.85039	12.88973	102	37	ANKLE CIRCUMF"ENCE	224.10012	12.64359	-13.24973	.24614
50	38	VERTICAL TRUNK CIR	1544.26299	68.69405	74	38	VERTICAL TRUNK CIR	1680.66849	71.57992	-136.40550	-2.88588
51	39	VERTICAL TRK C,SIT	1500.65984	65.56054	75	39	VERT TRUNK CIR/SIT	1613.05888	69.43687	-112.39904	-3.87633
52	40	BUTTOCK CIRC, SIT	999.97323	60.88607	73	40	BUTTOCK CIRCUM/SIT	1076.30121	67.24605	-76.32798	-6.35998
53	41	SCYE CIRCUMFERENCE	370.97848	22.88439	103	41	SCYE CIRCUMFERENCE	483.60959	27.76742	-112.63111	-4.88243
55	42	BICEPS C,RELAXED,R	256.11391	22.93311	104	42	BICEPS C-EXTEND/RT	307.81321	23.34424	-51.69930	-.41113
56	43	BICEPS C,FLEXED, R	267.94016	23.15454	106	43	BICEPS C-FLEXED/RT	327.41691	22.57789	-59.47675	.57666
59	44	ELBOW CIRC, FLEXED	269.76430	17.82707	109	44	ELBOW CIRC-FLEXED	312.39293	17.45950	-42.62863	.36756
60	45	FOREARM C, RELAXED	234.76378	13.78454	110	45	LOWER ARM C-EXTEND	281.52797	14.61580	-46.76419	-.83126
61	46	FOREARM C, FLEXED	249.75066	15.19692	111	46	LOWER ARM C-FLEXED	297.67396	15.80570	-47.92330	-.60878

Figure 38. Listing of Correlation Tape of 1967 USAF Men Vs. 1968 USAF Women (WAF) for 100 Variables.

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62	47	WRIST CIRCUMFERNCE	149.62520	7.11526	112	47	WRIST CIRCUMF"ENCE	175.86832	9.22987	-26.24312	-2.11461
63	48	BIACROMIAL BREADTH	358.43307	16.39323	50	48	BIACROMIAL BREADTH	407.27724	19.41351	-48.84417	-3.02028
64	49	BIDELTOID BREADTH	418.73648	23.13384	51	49	BIDELTOID BREADTH	482.35759	25.61348	-63.62111	-2.47964
65	50	CHEST BREADTH	279.94908	19.14410	52	50	CHEST BREADTH	327.83929	21.20119	-47.89021	-2.05709
67	51	WAIST BREADTH	241.27979	19.35696	53	51	WAIST BRDTH-OMPH"N	309.58645	23.82195	-68.30666	-4.46499
68	52	HIP BREADTH	349.68504	22.16016	55	52	HIP BREADTH	352.63063	18.83757	-2.94559	3.32259
70	53	HUMERAL BREADTH, R	61.33596	3.06809	57	53	ELBOW BRDTH BONE/R	70.82793	3.61485	-9.49198	-.54686
72	54	FEMORAL BREADTH, R	81.16430	4.51149	60	54	BUTTOCK CIRCUMF"CE	986.11274	55.03811	-904.94844	-50.52662
75	55	WAIST DEPTH	170.14436	16.71806	63	55	WAIST DEPTH-OMPH"N	223.00463	21.79307	-52.86027	-5.07500
77	56	BUTTOCK DEPTH	211.53333	17.89843	64	56	SCROTALE-A WAIST/S	254.35423	16.98753	-42.82089	.91090
78	57	THIGH CLEARANCE	124.36273	12.52023	65	57	SCRTL-SUPRASTERNLE	688.48586	34.11433	-564.12313	-21.59410
79	58	SHOULDER LENGTH	146.60787	10.21260	118	58	SHOULDER LENGTH	166.03618	12.60748	-19.42830	-2.39488
82	59	INTERSCYE	350.57165	24.40531	120	59	INTERSCYE	387.48043	37.62552	-36.90878	-13.22021
83	60	INTERSCYE, MAXIMUM	493.90341	32.86887	121	60	INTERSCYE MAXIMUM	615.39629	30.17511	-121.49288	2.69376
85	61	WAIST BACK	405.11181	22.15890	124	61	WAIST BACK-OMPHL"N	469.16870	23.74216	-64.05689	-1.58326
87	62	SLEEVE INSEAM	441.27192	24.15305	49	62	SCRTL-WAIST/BUTT/S	395.20993	29.17263	46.06199	-5.01959
88	63	SPINE-TO-SCYE LGTH	203.66142	13.57075	113	63	SLVE L/SPINE-SCYE	284.50904	18.10506	-80.84763	-4.53431
89	64	SPINE-TO-ELBOW LTH	533.17218	24.06219	114	64	SLVE L/SPINE-ELBOW	605.77997	26.16635	-72.60779	-2.10417
90	65	SPINE-TO-WRIST LTH	795.83832	33.18881	115	65	SLVE L/SPINE-WRIST	908.19562	35.18134	-112.35730	-1.99253
91	66	HAND LENGTH	183.83202	9.59008	134	66	HAND LENGTH	191.08666	8.19930	-7.25464	1.39078
92	67	HAND BREADTH	75.54121	3.89407	136	67	HAND BR/METACARPLE	89.01052	4.14629	-13.46931	-.25222
93	68	HAND CIRCUMFERENCE	183.18005	9.07175	138	68	HAND C/METACARPALE	215.53008	9.38321	-32.35003	-.31146
94	69	FOOT LENGTH	240.68609	11.27779	125	69	FOOT LENGTH	270.34118	11.89037	-29.65509	-.61258
95	70	FOOT BREADTH	88.67612	4.97739	127	70	FOOT BREADTH	97.66260	4.94664	-8.98648	.03074
96	71	HEAD LENGTH	184.10184	6.78907	150	71	HEAD LENGTH	198.70088	6.74496	-14.59905	.04411
97	72	HEAD BREADTH	145.15433	5.94739	156	72	HEAD BREADTH	155.98612	5.41646	-10.83179	.53093
98	73	HEAD CIRCUMFERENCE	548.65459	16.23607	141	73	HEAD CIRCUMFERENCE	575.14724	14.25937	-26.49265	1.97670
99	74	TRAGION-TOP HEAD	127.25144	7.64118	180	74	TRAGION-TO-VERTEX	134.44131	6.09917	-7.18987	1.54202
100	75	ECTOCANTHUS-TOP HD	117.64777	9.16908	175	75	XTRNL CANTHUS-VRTX	119.49853	7.70147	-1.85076	1.46761
101	76	PRONASALE-TOP HEAD	147.60525	11.71497	176	76	PRONASALE-TO-VRTX	147.42238	11.02870	.18287	.68527
102	77	SUBNASALE-TOP HEAD	159.12389	10.97692	177	77	SUBNASALE-TO-VRTX	160.87842	10.26629	-1.75453	.71063
103	78	STOMION-TOP HEAD	178.26194	11.21225	178	78	STOMION-TO-VERTEX	183.64114	10.00654	-5.37920	1.20571
104	79	MENTON-TOP HEAD	219.07034	11.39334	179	79	MENTON-TO-VERTEX	227.70509	10.24193	-8.63475	1.15141
105	80	TRAGION TO WALL	101.72441	8.99934	188	80	TRAGION-TO-WALL	103.35339	6.48766	-1.62898	2.51168
106	81	ECTOCANTHUS-WALL	163.65722	9.66342	183	81	XTRNL CANTHUS-WALL	177.87084	6.59513	-14.21363	3.08829
107	82	PRONASALE TO WALL	211.88871	9.60781	184	82	PRONASALE-TO-WALL	226.78797	7.49986	-14.89925	2.10795
108	83	SUBNASALE TO WALL	196.62415	9.81356	185	83	SUBNASALE-TO-WALL	209.90366	7.83880	-13.27951	1.97476
109	84	LIP PROTRUS"N-WALL	193.01102	10.58511	186	84	LIP PROMIN"CE-WALL	211.61296	8.55613	-18.60193	2.02898
110	85	MENTON TO WALL	182.33333	11.36097	187	85	CHIN PROMINCE-WALL	204.72865	10.46713	-22.39532	.89384
111	86	SAGITTAL CURVATURE	347.85984	14.88556	142	86	SAGITTAL ARC/INION	346.45015	16.54723	1.40970	-1.66167
112	87	BITRAGION-CORONAL	339.22257	14.04592	144	87	BITRAGION-CORONAL	357.55953	12.60126	-18.33696	1.44467
113	88	BIOCULAR BREADTH	96.72756	4.91864	162	88	BIOCULAR BREADTH	91.70593	4.84959	5.02163	.06905
114	89	BIAURICULAR BRDTH	158.33543	9.49797	161	89	EAR-TO-EAR BREADTH	188.30837	8.07816	-29.97294	1.41981
115	90	BITRAGION BREADTH	128.89239	4.99895	158	90	BITRAGION BREADTH	142.51914	5.55189	-13.62675	-.55294
116	91	BIZYGOMATIC BRDTH	128.99108	5.78027	159	91	BIZYGOMATIC BR"DTH	142.24653	5.14941	-13.25545	.63086
117	92	BIGONIAL BREADTH	101.86352	5.62440	160	92	BIGONIAL BREADTH	117.30332	6.91508	-15.43981	-1.29068
118	93	NASAL BREADTH	31.94278	3.29979	165	93	NOSE BREADTH	35.42280	2.93343	-3.48002	.36636
119	94	LIP LENGTH	43.78478	4.21083	166	94	LIP LENGTH	52.29617	3.74275	-8.51139	.46808
120	95	MENTON-SUBNASALE L	55.41207	5.10239	171	95	MENTON-SUBNASALE L	69.00210	5.26796	-13.59003	-.16557
121	96	MENTON-SELLION LTH	106.29556	6.12060	172	96	MENTON-NASAL ROOT	120.31679	6.08862	-14.03122	.03198
122	97	SUBNASALE-SELLION	45.46924	4.10213	168	97	SUBNASALE-NASAL RT	51.34287	3.72202	-5.87463	.38011
123	98	EAR LENGTH	52.36799	4.43874	154	98	EAR LENGTH	65.96929	4.25970	-13.60131	.17904
124	99	EAR BREADTH	29.81207	3.33019	153	99	EAR BREADTH	37.97350	3.01304	-8.16142	.31715
125	100	GRIP STRENGTH	29.89186	5.70287	12	100	GRIP STRENGTH	56.40429	7.59344	-26.51243	-1.89057

Figure 38 (Continued)

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DATA FORM IS

WAF(1,1) WAF(1,2) WAF(1,3) . . . WAF(1,100)

USF(2,1) WAF(2,2) WAF(2,3) . . . WAF(2,100)

USF(3,1) USF(3,2) WAF(3,3) . . . WAF(3,100)

USF(99,1) ...USF(99,98) WAF(99,99) WAF(99,100)

USF(100,1)...USF(100,98) USF(100,99) WAF(100,100)

0.00000	.22300	.14773	.16119	.01056	.04811	.04354	.06760	.04802	-.02257	.03874	.01015	-.03459	-.04991	-.00291	-.05527
.04366	-.00222	.09088	.10888	.13417	.04566	-.07248	.08601	.06330	.04660	.00250	.08606	.03664	.15902	.23298	.29059
.23427	.15469	.14510	.04740	-.02340	.27232	.23543	.27651	.26181	.28793	.29278	.13128	.19445	.17518	.10172	.14854
.22658	.23148	.14615	.19438	.13712	.11505	.28917	.16379	-.00923	.02766	.19376	.17067	.00952	-.08284	.15085	.12736
.07696	.08018	.13986	.13752	.05550	.00664	.11775	.19046	.09454	.06679	.06056	.09613	.06943	.05749	.06486	.08616
.13783	.14604	.06372	.06907	.14457	.09609	.06660	.08637	.12329	.24534	.08884	.14638	.06335	.04385	.03776	.18853
.25853	.27144	.13694	.15006												
.11296	0.00000	.59666	.56456	.58295	.53251	.54055	.55221	.55275	.45714	.49651	.45993	.46763	.36556	.40794	.43052
.15765	.24643	.48131	.44781	.49730	.16027	.37010	.56509	.69408	.44117	.37595	.43258	.42210	.58195	.83502	.80318
.82440	.84043	.81940	.75241	.59125	.78718	.73704	.90398	.77628	.80264	.80540	.57218	.80773	.77934	.64562	.49510
.79804	.70083	.76760	.77036	.53821	.48686	.73635	.80402	.71353	.27336	.53411	.55276	.29826	.28820	.42983	.56886
.56613	.38300	.41710	.49499	.51002	.39260	.30386	.28964	.40285	.22175	.16778	.14543	.18325	.18588	.27225	.20412
.29121	.34448	.31114	.26956	.30327	.23689	.30295	.23407	.21599	.39189	.35797	.34657	.10002	.08298	.21067	.26449
.16549	.28040	.13922	.36086												
.16887	.53395	0.00000	.61048	.60431	.07451	.09085	.09664	.10151	.03693	.07405	.05035	.08543	.01731	.04729	.03585
-.00880	.08378	.10451	.11153	.14680	.09677	.01484	.22469	.28955	.06801	.02317	.08429	.06804	.30582	.52992	.50289
.54177	.63000	.56406	.48769	.31959	.41102	.35414	.59750	.49510	.71740	.69185	.30068	.55948	.53731	.30805	.14907
.52916	.40163	.46907	.52971	.20218	.28181	.49844	.59831	.41914	.03787	.30182	.29427	.02060	-.05565	.18377	.17766
.13281	.00650	.05736	.15427	.05225	.05525	.05795	.15559	.10667	.05969	.02191	.01341	.01414	.00414	.03306	.07540
.09226	.09324	.08177	.06427	.13174	.03531	.12437	.08116	.11629	.20756	.20672	.23530	-.04703	-.04872	.05174	.05412
.03070	.12228	.04212	.09411												
.17951	.56632	.57489	0.00000	.65914	.00605	.02744	.04055	.03837	-.02130	.02641	.01399	.05640	-.02088	.00602	.00044
.04809	.03770	.02599	.02025	.09443	.03968	-.01270	.18129	.22507	.03747	.00204	.04688	.06370	.36439	.58153	.60901
.64612	.52262	.41022	.34277	.17579	.37461	.32312	.54902	.53263	.63179	.60581	.28025	.48377	.46578	.27295	.15578
.55630	.47194	.53533	.42513	.11843	.20589	.60847	.57724	.32933	.03223	.36359	.32436	-.03401	-.08099	.19812	.13861
.10110	-.01367	.04552	.12404	.03845	.04001	.02104	.13283	.09866	.07002	.01224	-.01964	-.00139	-.01433	.00932	.08499
.09868	.10366	.11963	.12086	.19698	.03326	.12917	.06438	.10453	.20663	.18929	.22165	.05488	-.01200	.04172	.03548
.00325	.13599	.02868	.06419												
-.01560	.62267	.67542	.68515	0.00000	.09785	.12362	.12194	.12666	.05705	.10973	.07797	.14430	.07014	.09060	.03196
.02910	.08357	.08956	.09649	.11978	.07105	.10145	.23279	.28435	.10819	.03790	.10534	.06254	.30926	.53978	.55337
.64087	.56381	.44390	.37484	.22552	.35684	.32670	.55080	.48717	.58515	.56502	.29850	.47941	.47237	.31194	.14035
.52984	.42339	.57276	.44394	.19738	.23909	.55613	.53734	.41641	.04042	.34007	.33108	.03632	-.02974	.23334	.17840
.14457	.04356	.08400	.16836	.10015	.06587	.05159	.14155	.09680	.06307	.01090	-.02650	-.01943	-.02086	.00599	.08089
.08604	.09343	.10372	.10456	.16196	-.02520	.12393	.11842	.05009	.16587	.23441	.27232	-.00676	.00877	.03463	.02520
-.02746	.08258	.01000	.06389												

Figure 38 (Continued)

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Survey of civilian adults (1960-1962, 20 variables); and a survey of law enforcement officers (1974, 23 variables) are presented for the use by engineers who need them in solving design problems and by anthropologists and statisticians, whose analyses and understanding of the interrelationships of body size data depend significantly on these coefficients. Sample sizes in these surveys ranged from 2000 upward...."

Ten correlation matrices are included on the tape, four from the Health Examination Survey of civilian adults and one each from the remaining six surveys. Matrices were produced one at a time on separate tapes and then merged into one eleven-file tape. The first file is a table of contents and includes a routine for abstracting data from the tape. Paul Kikta of UDRI is directly responsible for the programming runs needed to produce the matrices and the final tape, as well as the table of confidence limits included in AMRL-TR-77-1.

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